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The Role of Biologists in Modern Warfare

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A Symposium by
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VOL. 3 AUGUST 1947 No. 8

EDITORIAL

THE SOVIET PLAN FOR ATOMIC ENERGY CONTROL

In recent months, we have often heard—and spoken—of the "Russian plan" as an alternative to American proposals for the control of atomic energy. This, however, was a misnomer. Until June 11, there was no "Russian plan" for the control of atomic energy, but merely a proposal for a convention outlawing atomic weapons with the vague suggestion of a control and enforcement system to be evolved at some later date.

In speeches by Molotov and Gromyko, the Soviet idea of the control system became somewhat clearer, but only from the negative side: this system was *not* to include ownership of materials, or management of plants, or cooperative research and developmental activities, but was to be restricted to inspection. Inspection was not to be "unlimited," it was not to include, for example, aerial surveys.

However, all *positive* aspects of the inspection system remained in the dark. Gromyko could not offer a definite answer even to the question as to whether the inspectorate would be international or national in composition.

A DELAYING ACTION?

On June 11, apparently upon receipt of new instructions from home, Mr. Gromyko presented proposals which for the first time deserve the name of a "plan." He proposed unambiguously that inspection should be carried out by *international personnel.* He specified that inspection should encompass "all mines and plants capable of producing atomic fuels."

Further, in open reversal of the previous Soviet stand, he agreed that the international control agency should operate its own research laboratories in order to keep in the forefront of nuclear science and technology and thus to be able to adjust inspection methods to their progress.

Thus, something that begins to look like the timid outlines of a true control plan, began to emerge from the Soviet. If Mr. Gromyko's June 11 proposals had been offered a year ago, in answer to the plan presented at that time by Mr. Baruch, they would have provided a legitimate reason for rejoicing and some hope for the successful completion of the control negotiations.

However, the fact that the first real Soviet counter-proposal comes a year after the negotiations have begun, makes optimism out of place. It is difficult to believe that it took the Soviet leaders a whole year to begin to understand the first things about atomic energy and the elementary requirement for its effective control.

Suspicion cannot be avoided that new Soviet proposals are made only when general resentment at the negative attitude of the U.S.S.R. threatens to hasten a final showdown, and are only intended to drag the negotiations out as long as possible.

Assuming that these are delaying tactics, they raise questions as to their purpose. Is the delay because the Russians do not want international control or because they do not believe it feasible? Or, perhaps, they believe delay will improve their bargaining power, giving them time to equalize their position with that of the United States through further progress in their own atomic energy development?

LESS PESSIMISTIC INTERPRETATION POSSIBLE

This negative interpretation is not the only possible explanation of the Soviet attitude. Another perfectly legitimate explanation is that they genuinely want or at least realize the necessity for, international control. However, the means required to achieve such control is novel and abhorrent to them and runs contrary to the general principles which determine their atti-

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tude towards "capitalist" nations. Therefore, every step they make towards the implementation of the principle of international control is done with the greatest reluctance, after prolonged deliberations and vacillations, and perhaps even internal struggles between the more and the less enlightened elements in the Soviet hierarchy.

SOVIET TIMING TOO SLOW

Which of the two interpretations is correct, we do not know and we don't think anybody outside the U.S.S.R. knows. What is certain, is that this dribble of Soviet concessions, interrupted by long months of perfectly exasperating repetition of the same often totally meaningless phrases which make real "give and take" negotiations impossible, has produced an atmosphere of suspicion and hopelessness.

This could have been averted by a faster timing of the same proposals. Using Mr. Baruch's language, it took the Soviet Union six months to say the "B" of inspection after the "A" of international control. It took another six months to add the "C" of international inspectorate and the "D" of cooperative international research.

How long will it take the U.S.S.R. to spell out the whole alphabet of an effective international control mechanism? Is there any hope that this could be achieved within the time which remains before the atomic armament race will destroy the last chances of reconciliation?

The Soviet Union has still travelled only a small part of the road to a truly effective international control. The next question which they will have to answer, however much they might like to avoid it, is "what do you suggest doing about illicit uranium mining and processing?"

Mr. Gromyko has pretty well spelled out what must be inspected from the mine to the finished product, in the field of "legitimate" production of fissionable materials. But does the Soviet Union propose to rely entirely on national governments in reporting the number and location of mines and plants?

This proposal would be as obviously unrealistic as the reliance on a convention outlawing atomic bombs. Here is where extensive aerial surveys of mining, and "snooping" in establishments officially unrelated to atomic energy, will have to come into the picture.

How long will it take the Soviet Union to concede that some such highly disagreeable provisions are inevitable in a control system based entirely on inspection?

MANAGEMENT MAY BE THE LESSER EVIL

If and when the Soviet Union arrives at this stage, it may begin to dawn on her why some scientists in America—without being in the service of vested coal or oil interests—have suggested the limitation of the production of atomic fuels to a level excluding large scale power production.

Perhaps she will realize that this limitation would greatly facilitate inspection and incidentally keep the margin between atomic disarmament and full atomic preparedness immensely wider than it can be if each nation is allowed to accumulate unlimited stocks of atomic fuels for power production.

Furthermore, will the Soviet Union, at this stage of spelling out the alphabet of atomic control, understand why Messrs. Lilienthal, Oppenheimer, Winne and Thomas have discarded the idea of control by inspection in favor of control by ownership and management?

Will the Soviet's next step be the reluctant concession that it is less distasteful to engage in common exploitation of atomic energy with the hated and suspected capitalist system, than to allow the agents of this system to fly freely over a large part of the Soviet territories and look at will into Soviet laboratories and plants?

Will she understand that managerial control has not been devised as an opening wedge for capitalist penetration into socialist economy, but as a provision for minimum interference by the atomic energy control agency with the diverse economies of individual countries?

TWO ECONOMIC SYSTEMS OR TWO ARMED CAMPS?

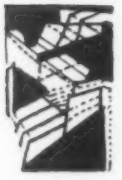
Proposals of the type of those made by Gromyko on June 11 rekindle the feeble hope that the Soviet Union may be advancing—desperately slowly, but still advancing—on this road to understanding. But unless the progress is accelerated, it my fail to keep pace with the rising tide of impatience and disappointment. It must be in the interest of the Soviet Union to stem this tide more rapidly and more effectively than it has done heretofore. It is difficult to judge how much the mutual mistrust originating in existing atomic armaments on the one side and the striving to come into possession of such armaments on the other, has already contributed to the separation of the world into two camps. At present, the most ostensible cause of this estrangement lies in the economic field—in the division between the sphere of economic cooperation of the Western powers, and the sphere on which the Soviet Union imposes its pattern of international economic collaboration. This division of the world into two economic units is deplorable enough in itself, and full of danger for the world peace; but it perhaps could be overcome by an overall economic cooperation between the two systems, if it were not for the simultaneously rising political enmity and mutual preparations for the protection of an illusory military "security" of the two spheres. Without the elimination of an atomic armaments race by international control, the two worlds which are shaping up now will be not merely two competing economic systems but two camps of enemies armed to the teeth and watching each other's preparations in hysterical anguish.

This is the light in which one must judge the statements such as the one by the British New Commonwealth group and the Parliamentary Atomic Energy Committee reprinted in this issue, which calls for a Big Three meeting to break the deadlock in atomic energy negotiations.

The widening rift in the politico-economic structure of the world should not serve as a pretext for abandoning the attempt to stop the arms race through the establishment of international control of atomic energy. It makes the establishing of such a control all the more imperative.

E.R.

ORGANIZATION AND ADMINISTRATION OF THE INTERNATIONAL AGENCY



David E. Lilienthal

The following report is a condensed version of the statement made by Mr. Lilienthal before the Control Committee of the United Nations Atomic Energy Commission on June 2. Mr. Lilienthal analyzes here the organizational and administrative aspects of the two great projects directed by himself—the Tennessee Valley Authority and the U. S. Atomic Energy Commission—showing the differences and similarities between such national agencies and the proposed International Control Agency.

Perhaps the most useful thing I could do would be to discuss some of the problems with regard to the management, organization, and staffing of two large public undertakings of which I have knowledge, for an international agency in this field would be a public undertaking, though international rather than national in its genesis. The undertakings to which I refer are the United States Atomic Energy Commission and the Tennessee Valley Authority.

There is perhaps a special point in discussing, by way of analogy only and in some respects by way of contrast rather than similarity, the organization and functioning of the United States Atomic Energy Commission. In the first place, of course, the subject matter is roughly the same subject matter as would concern an international agency in this field; at least, we may assume, generally speaking, that that is true, the subject matter being atomic energy. In the second place, there is a special point, inasmuch as under the Committee report of last December and under preceding proposals discussed with and before this Committee and other Committees of the same body, the physical enterprise, which is the subject matter of the Atomic Energy Commission's work, would be subject to the terms of an agreement worked out and accepted by the various nations, after the adequate safeguards towards which we are all working had been agreed upon and put into effect. Therefore, the physical subject matter of the Atomic Energy Commission of the United States has some rather direct bearing on the management problems of an international agency, when, as, and if created.

There are some similarities between an international agency and the United States Atomic Energy Commission, organizationally speaking and in other respects. There are also some striking contrasts and differences. It may be that the differences will throw more light on your problem than the similarities. The chief difference, perhaps, is in the purpose of the Atomic Energy Commission of the United States, as defined in its Charter; that is to say, the Act of the United States Congress, which confers jurisdiction and responsibility upon the Atomic Energy Commission of the United States.

REDUCTION OF NATIONAL RIVALRIES ESSENTIAL

The purpose of an international agency in this field, according to some views which have been presented to this Committee and other Committees and according to a view to which I subscribed somewhat more than a year ago, is the elimination of national rivalries in the dangerous aspects of the development of atomic energy. That would appear to be the prime purpose of an international agency. When I say dangerous aspects, I mean dangerous to the security and the peace of the world.

The Atomic Energy Commission of the United States, however, does not have that purpose because, of course, its powers derive from the law-making body of a single nation rather than from the law-making bodies of the nations of the world. Its purpose and function is, of course, to develop atomic energy along lines of research, engineering improvements, and the production of fissionable materials and weapons on behalf of the United States of America. It is, therefore, clear, when studying this matter from an organizational point of view, that the contrast between a national commission and an international body stems from this basic difference in purpose.

It is unnecessary for me to say that the people of the United States have indicated in the strongest terms their desire that an international system shall be worked out. In this connection, resolutions have been passed looking toward the elimination of national rivalries. Until that day comes, however, the Congress has also set up this national commission with the purpose of furthering atomic energy development within the United States.

PRINCIPAL AMERICAN SITES DESCRIBED

It has occurred to me that some of the points I seek to make in respect to the organization and management of the United States Atomic Energy Commission might be somewhat clearer if I were to refer to some of the physical installations of the Commission. Although this is a closed meeting, I shall not refer to any facts which are not wholly public at this time, nor shall anything else I say refer to any matters which, under this law, may not be spoken about quite freely. This map, upon which I will indicate the principal installations of the Commission, does give a sense of reality to the discussion of some of the policies of organization and management which the Commission is pursuing. This map is a map of the United States, on which you will observe the points at which some of the principal installations—

not all of them—of the United States Atomic Energy Project are located, or are to be located.

I might start with the point at which the bombs were made. This is the Los Alamos Laboratory, on top of a mesa in the mountains of New Mexico. At this point important research and development activities are going forward, particularly in relation to the use of atomic energy for atomic weapon development and production. It is, of course, a principal and important point in the whole organizational pattern of the Atomic Energy Commission.

Then, at this point in the eastern part of the State of Washington, which is in the northwestern part of the United States, on a very large tract of land, is the Hanford Plutonium Works. It is at this point that the United States has produced plutonium in the quantities required by the programme. This is a very extensive physical installation. It cost many scores of millions of dollars. It was constructed in a relatively short period of time only by a very remarkable work schedule. It extends over a very large area of land, and it is now in operation.

At Berkeley, California, are the research activities carried on for the Atomic Energy Commission of the United States by the University of California; here there are the radiation laboratories where fundamental research and development in this field is carried out. These are rather extensive and very important activities in connection with the development of new knowledge, especially new fundamental knowledge in the field of nuclear research and development. A great deal of emphasis is placed by the Commission upon this and similar laboratories elsewhere in the country.

Coming to the Middle West, the inland empire of the United States, near Chicago, there is the Argonne National Laboratory. It is well known to you that in the laboratory, which was known at that time as the Metallurgical Laboratory of the University of Chicago, the first chain reacting pile in the world was developed and operated. This occurred for the first time on Dec. 2, 1942. The Metallurgical Laboratory, or the Argonne National Laboratory, as it was later called, was therefore appropriately the center of much of the continuation of research work in this field, both research in the fundamental nuclear science involved and also research in improvements and in the very important fundamental discoveries relating to the next steps in the development of atomic energy.

These research efforts are carried on in and around Chicago, and the Commission is pressing an expansion and intensification of effort in that laboratory. This will take place on some four thousand acres of land recently acquired, or to be acquired, in the vicinity of the forest preserves of Cook County, Illinois, where one of the most important, if not the most important at the present time, types of work in fundamental research and development in the United States will be carried on.

ATTEMPTS TO DRAW ON ALL RESEARCH SOURCES

It has been our effort, as it was that of our predecessors, an effort that we have accentuated—and it certainly has a great deal of bearing on the problem of management of this Commission, to draw into this research field as many of America's institutions of research in the physical sciences as is feasible. This calls for a high order of administrative arrangement. From the manager's point of view, this is a different means of organization. It is much easier to have one very large laboratory than to seek to draw on and tap all the resources and skills embodied in people and in the going institutions in the research field. But we have chosen to follow the latter route, thereby providing diversity, and carrying out our responsibility for the dissemination of information and the training of individuals in the United States who will know this new field.

Therefore, at the Argonne National Laboratory we will have not simply the University of Chicago, not simply a national laboratory, though there will be such a laboratory, but we have there an arrangement of twenty-nine of the major universities and institutes of the Middle West, whereby professors and graduate students in those universities, in the fields of physics and chemistry and other fields, will work in this very important laboratory in the Chicago area. These universities are located as far west as Colorado. They include universities in Oklahoma, Kansas, Nebraska, Minnesota, Iowa, and Missouri, as well as the somewhat nearer States of Wisconsin, Michigan, Ohio, Pennsylvania, Indiana, and Illinois. There are twenty-nine in all; I may have omitted some of the states. I shall want to revert to this administrative mechanism again, because I think it may have some bearing upon the problem of diversity in calling upon all of the existing institutions and resources in research and learning, rather than compressing within a government agency or a government laboratory all of the personnel and all of the technical resources available, mind you, in the field of fundamental research.

Here in Tennessee, in the fields from which I come, more recently certainly, is Oak Ridge, which is a place well known to you. It is here that the great separation plants described in the Smyth Report are located, plants which separate U-235. And there is here a laboratory known as the Clinton Laboratory, where fundamental research work and research in process improvement, the development of methods, technology, metallurgy, and so on, is being conducted by a rather large staff of men and women.

The Oak Ridge facilities also represent a very large outlay of money, an outlay in excess of a billion American dollars, representing by American standards a very great, a magnificent, achievement from our point of view, in terms of construction under schedules that are quite remarkable, all the way from the technology to the speed of construction of plants and facilities never before built. A good deal of work is going on there of a new kind as well.

$500,000,000 EXPENDITURE CONTEMPLATED

By way of indicating the scale of effort in the present atomic energy activities of the United States, if it can be measured somewhat by the expenditures the United States is putting into this undertaking, in round numbers, in the fiscal year which ends for us this coming June 30, the United States will have expended in the order of four hundred million dollars in a twelve-month period. The President's recommendation, now being considered by the Congress for the fiscal year beginning July 1, is in the order of five hundred million

dollars. This gives a rough idea of the scale of effort involved.

ADDITIONAL SITES DESCRIBED

There are two other geographical points in the United States where physical facilities are located that seem worthy of special mention. I should say at this juncture there are scores of other places in the United States which I shall, either for reasons of security of information or because they do not add anything to the organizational picture, omit. There are two other places that need mention. One is on Long Island, not far from here, at Camp Upton. Camp Upton was a United States Army camp, a reception center, I believe, during the war. It is a rather large tract of land on which a laboratory, which will be known as the Brookhaven Laboratory, is coming into being. It, too, represents a departure from administrative methods in this respect: that, while it will be a national laboratory, the responsible parties will be a group of nine of our leading Eastern universities, universities whose names are known pretty well throughout the world, such as M.I.T., Cornell, Yale, Rochester, Princeton, Columbia, Harvard, Pennsylvania, and Johns Hopkins. They are joined together in a non-profit corporation called "Associated Universities, Inc.", which is simply a device for working together. Subject to the policies of the Commission, they will carry on largely fundamental research in this field, in which so much is to be known and so little is actually known at present of the nature of the forces within the nucleus.

The Brookhaven Laboratory, which is presently in the process of recruiting personnel and which already has a substantial staff, will undertake the exploration of some fundamental questions that may open completely new vistas in this field in terms of fundamental knowledge. A considerable budget will be required to complete the physical facilities required for this undertaking.

Near Schenectady, New York, in close proximity with the works of the General Electric Company, one of the two or three major companies of the United States engaged in the manufacture of electrical equipment, there will be a laboratory of the Atomic Energy Commission known as the Knolls Laboratory. This laboratory will be operated by the General Electric Company, a private corporation, according to the policies of the Atomic Energy Commission of the United States and the purposes set out in the Act. Here there will be efforts to solve some of the fundamental engineering problems, problems of application in the field of power and other fields by a company that has had considerable experience in somewhat related fields. The problems of metallurgy, heat transference, and some of the chemical problems, et cetera, will be dealt with.

REGIONAL ORGANIZATION AIDS NATIONAL ADVANCEMENT

I should like to call your attention to a few of the characteristics of this United States undertaking which may or may not, by reason of analogy or difference, throw some light on how an international agency might operate, bearing in mind again that, until there is international accord on this problem and international safeguards satisfactory to the nations of the world, the purpose of the United States Atomic Energy Commission is to maintain and, indeed, increase the pre-eminence of the United States of America in the field of the development of atomic energy and atomic weapons.

This is the frank, candid, and declared purpose of this undertaking. I emphasize that because, obviously, the purpose of an international undertaking would be quite otherwise.

You will note the diversity of location of facilities. I think this is a matter of some importance managerially speaking. There is not just one very large laboratory, although, from a management point of view, especially in the absence of international agreement, a single laboratory would be a convenience to those of us who are responsible for management, because it would simplify, or appear to simplify, the problem of security of information.

I should like to underscore, too, the emphasis upon regions. The United States is a large country, but, compared to the Western Hemisphere alone, it is not a large area. Compared to the world as a whole, it is a relatively modest portion of the earth's surface. However, it is a large country when judged by the standards of management with which I have had any experience. Accordingly, instead of seeking to operate this national undertaking wholly on a national basis, we have emphasized, as much as possible, these regional centers. There is a regional center about Oak Ridge. There is a regional center about the Argonne Laboratory at Chicago, about the Berkeley operation on the West Coast, and at Hanford and Los Alamos, potentially regional centers, and at the Brookhaven undertaking. Consequently, within the same country and under the same general responsibility, there is this effort to break these operations down on a regional basis.

Indeed, we have made up our minds in the Atomic Energy Commission that we will appoint as field managers of the major installations men of such stature and responsibility that they may manage those undertakings within their respective regions with a very great degree of autonomy, so they may be fitted into the local customs, the local resources, the habits, institutions, and ways of doing things, all of which are different in different parts of the United States—perhaps not as different as in different parts of the world, but quite different. It is the encouragement of diversity and regional differences within the United States that seems to us well worth promoting. This is an important principle of the Tennessee Valley Authority. I think it has some bearing on the problem of a world-wide organization.

ACTIVITIES FITTED INTO EXISTING WAYS OF LIFE

There is a third point in respect to the management of the United States Atomic Energy Commission's operations that I can mention. We have concluded that, although the statute or the law under which we operate makes it possible for the Government of the United States, as represented by the Atomic Energy Commission, to have control in detail over all aspects of nuclear science, research, and development, we do not find it necessary within the United States that, subject to the policies of this law, everything be operated directly by the Atomic Energy Commission. We have made an effort to fit this new activity, which is not only new scientifically but presents the possibility of a new industry to the world

—an activity which requires government control of the dangerous aspects represented by physical properties—into the existing United States institutions and the existing pattern and habit of doing things in the United States.

Thus, research in the United States in the past has been conducted in various ways. Fundamental research has been primarily within the Universities and private institutes, such as the Mayo Foundation of Rochester in the medical field and so on.

Research in the United States has also been carried on in government laboratories, such as the National Bureau of Standards, or laboratories of the Department of Agriculture; research has also been conducted within private industry.

It has not been our purpose to see how much of the existing way of doing things we could change, but rather how much, within the objectives, purposes, and limitations imposed upon us, we could fit this new activity into the existing way of doing things. This is a very natural administrative consideration, a proper one, in my mind. However, it is one that has been somewhat obscured by inaccurate references to the very extraordinary and precedent-shattering aspects of this undertaking. It is true the scientific and engineering aspects are new and precedent-shattering, but it does not follow from that, in the opinion of the Atomic Energy Commission of the United States, that within the limitations of security of information and others, the existing pattern of doing things in the field of research should not be pursued by one means or another, as far as possible, rather than the complete disruption of those existing ways of doing things. All of this is predicated upon national development; it is predicated upon limitations which I have described as security, or the requirements of secrecy; it is predicated, of course, upon the purpose of this Commission—to wit, the furtherance of atomic energy development for the United States of America.

This does not mean that, when we call upon the Massachusetts Institute of Technology, a famed private institution in the field of research and development in engineering, or the General Electric Company, to carry on certain research and development work on our behalf through contracts or otherwise, this is turned over to these private agencies without limitations being imposed. It is worthy of note, for example, that, under the premise of national rivalries, by which this law necessarily was passed, all the personnel employed by the Massachusetts Institute of Technology, in carrying out research for the United States Atomic Energy Commission, or all the personnel employed by the General Electric Company, a private company, are subjected to the most rigid investigation concerning their loyalty, character and associations, and are expected to, and in fact do, observe regulations in respect to secrecy. This will continue, I have no doubt, until adequate international arrangements have been worked out.

COMMISSION ENCOURAGES BASIC RESEARCH

There is a fourth aspect to the organization of the Atomic Energy Commission of the United States which may perhaps throw some light upon the difficulties of the problems of an international agency, only by analogy, of course. The Atomic Energy Commission could, if it chose, establish a rather complete overlordship, a complete control and management in detail of all phases of nuclear research relating to these matters, certainly to research and development.

Broad governmental control by ownership, operation, and management of physical facilities, which I have roughly described to you, is vested in this national Commission. It is our effort—and it is not a futile effort—to seek areas in which research and development by agencies other than the Atomic Energy Commission in the United States can be carried forward. It is not our purpose to make this exclusive jurisdiction as broad as possible, but rather to make it only as broad as is necessary for the objectives stated.

I think the radioactive isotope situation for research is an example of this. Again, I say these are matters that are public and not secret. At the Oak Ridge installations, the Commission has a radioactive isotope factory. In other words, it has a means of producing radioactive species, radioactive isotopes of a number of elements that are very useful as tracers in research—research in industry, in the field of biology, in medicine, in therapy; perhaps research in the field of agriculture may prove to be the most important of all.

It is my personal hunch that the value of research in the field of agriculture, in the principles of plant growth, in the field of insect control, and how nature is able to transform the energy of the sun into energy available to man,—that the new knowledge made possible by these radioactive isotopes such as carbon 14—may repay the people of the United States for their entire expenditure laid out for all the facilities thus far provided, which now total in value about 2½ billions of dollars. In any case, these radioactive isotopes could be held exclusively by the Atomic Energy Commission. Research in various fields of agriculture, industry, biology, and so on, could be held closely by the Commission and carried on only in its laboratories. We find no necessity for that in terms of the common defense and security and in terms of secrecy of information. That being so, we welcome the encouragement of research with these materials, which are presently supplied to more than 60 agencies throughout the United States—universities, hospitals, and like institutions—under contract.

METHODS OF POWER DISTRIBUTION DISCUSSED

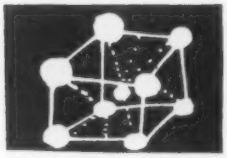
In this same connection, some consideration might be given to the policy, as I understand it, that is expressed, or certainly implied, in the Atomic Energy Act of 1946, the United States Act, in respect to large power reactors.

That is a reactor yet to be built, yet to be designed, but a reactor which will undoubtedly some day be designed and built, which may be capable of producing heat which can be transferred to a, let us say, conventional steam turbine, and, by that turbine, produce electricity through a conventional generator. This large reactor, being dangerous in terms of security, would, on the proposals made, be designed, owned, and managed by the international agency. Similarly, and prior to that time, such a reactor—if international agreement has not by that time been reached—such a large reactor, producing electricity, would be designed, owned, managed and operated by the Atomic Energy Commission of the United States.

But under the Act of Congress, it by no means follows that because the reactor itself must be kept under the ownership, management and operation

(*Continued on Page* 231)

A CRITIQUE OF ARMY AND NAVY THINKING ON THE ATOMIC BOMB



Bernard Brodie

After compiling the summaries of Army and Navy Thinking on problems posed by the advent of atomic weapons which appeared in the June and July issues of the BULLETIN, Dr. Brodie prepared a critical analysis of these views. We reprint here in full for the first time with the permission of the Legislative Reference Service of the Library of Congress, Dr. Brodie's critique of Navy Thinking and an excerpt from his critique of Army Thinking.

Especially cogent and significant in the foregoing synthesis of U. S. Navy authentic (but unofficial) views are the following four theses:

1 the Navy's plans for the future must cover at least two radically different but equally conceivable situations—i. e., a war in which atomic bombs are used reciprocally on a substantial scale and one in which they are not so used;

2 the kind of force necessary to fight a war fifteen or more years hence would not necessarily be suitable for one which might occur a good deal sooner;

3 guided rockets of ranges measured in thousands of miles can by no means be considered to be "around the corner"; and

4 for shorter-range rockets like the V-2 or for bombing aircraft the fleet itself might provide ideal launching platforms.

Also persuasive is the argument that a fleet, especially when under way, is already a highly unattractive target for atomic bombs when compared with various targets ashore, and measures are feasible which will increase that relative immunity. On the other hand, the validity of some of the other arguments depends on certain unexpressed assumptions, which deserve at least to be pointed out.

First, a major part of the Navy's presentation seems to rest on the assumption that atomic bombs will remain for a rather long time to come a very scarce and expensive commodity of war. This assumption is reflected most clearly in the idea that unescorted long-range bombing planes (i. e., carriers of subsonic speeds) will not be a sufficiently "reliable" means of delivering atomic bombs, an idea which implies that atomic bombs will remain too scarce to permit of any appreciable wastage.

The same point is made by General H. H. Arnold, formerly commander of the U. S. Army Air Forces, who in his *Third Report to the Secretary of War* observes: ". . . the great unit cost of the atomic bomb means that as nearly as possible every one must be delivered to its intended target."[1] General Arnold goes on to add that the very heavy bomber is as yet the *only* way to deliver the atomic bomb, but by insisting that it can be "certain of success only when the user has air superiority"—which superiority would presumably depend largely upon vigorous fighter plane support of attacking bombers, the fighters being inevitably of much lesser range than the latter—he leans towards concurrence with the contention that bombers operating from distant bases are not *by themselves* a sufficiently reliable means of delivering atomic bombs.

CARRIER LOSS ANALYZED

The point which is concealed in this reasoning and which must be clearly realized is that the degree of reliability necessary in any carrier depends on the number of atomic bombs which may be available to either belligerent. In fact, it is easy to demonstrate that if available in sufficient numbers, *atomic bombs need not require nearly as "reliable" a means of delivery as ordinary bombs.* The latter *inevitably* require a high degree of reliability, for such huge tonnages of ordinary bombs must be delivered to accomplish real strategic results that even the largest of air forces must be able to use the same bombing planes over and over again.

It was, for example, frequently stated during the recent war that an average of 10 per cent losses of planes per attack represented the maximum tolerable loss for any strategic bombing campaign. That figure must not be taken too literally, since the actual figure of loss tolerance for any one campaign must depend on a host of variables. For most long-term bombing programs the 10 per cent figure would probably be considered too high. But the general idea represents an approximation of the truth, and as such is sufficient for our purposes.

90% LOSS OF ATOMIC CARRIERS POSSIBLE

With atomic bombs, on the other hand, it is entirely conceivable that a 90 per cent rate of loss of carriers might not be at all excessive.

A convenient illustration may be found in the amount of destruction accomplished by one atomic bomb at Hiroshima. It has been estimated by the United States Strategic Bombing Survey that to equal that destruction in a single attack with ordinary bombs would have required the work of at least 210 B-29s.[2] Assuming that the 10 per cent figure of loss tolerance were applicable in this case, a sacrifice of twenty-one planes would not be considered excessive for the ends achieved. If that loss-tolerance figure be deemed too high for B-29s operating on distant missions, one could reduce it by more than half and still come out with ten planes as a not unreasonable price to pay.

That means that if atomic bombs were plentiful enough to make the B-29s or their counterparts the critical items in computing loss tolerance rather than the bombs themselves—

1. See printed edition, dated November 12, 1945, p. 66.

2. The United States Strategic Bombing Survey: *The Effects of Atomic Bombs on Hiroshima and Nagasaki* (Government Printing Office, 1946), p. 33.

and if we could discount entirely effects on crew psychology—it would be acceptable to lose ten planes for every one which got through to the target with an atomic bomb, which gives us a loss tolerance of over 90 per cent.

That proposition assumes, of course, that the problem of plane and crew replacement is the same regardless of what kind of bombs are used and that only targets are selected where the concentrated destructive power of the atomic bomb can be more or less fully utilized. The logistics and maintenance problem is, of course, enormously simpler where the atomic bombs are used. But, assuming that all other considerations remain the same and that the crtical item in reckoning losses remains, as it is now, the carrier plane—a loss tolerance of over 90 per cent with atomic bombs is permissible for an amount of destruction which with ordinary bombs would permit a loss tolerance of only 5 per cent.

DEMANDS FOR RELIABILITY VARIES

Let us approach the same idea from another direction. Supposing Country A should have available 5,000 atomic bombs and it should estimate that 500 such bombs dropped on the cities of Country B would practically eliminate the industrial plant of the latter nation. It could then theoretically afford a wastage of bombs of roughly nine to one to accomplish the desired result. And if, as has been hinted by a competent authority, the cost of production of the bomb under existing processes will ultimately come down to one million dollars each,[3] Country A in our hypothetical example would have gained by an expenditure of only five billions of dollars in bombs an advantage so inconceivably overwhelming as to make easy and quick victory absolutely assured—provided it could somehow prevent retaliation in kind.[4]

The two illustrations just offered are not to be construed as enjoying even in the slightest degree the character of predictions. They are intended only to demonstrate the fact that the degree of reliability demanded for any carrier of atomic bombs is an extremely variable figure rather than one fixed at a high level, and that the range within which the figure may vary is far greater than is true for manned aircraft carrying ordinary bombs.

HOW LONG WILL BOMBS BE SCARCE?

To be sure, the Navy would probably not disagree with the proposition just expressed or with the reasoning of the preceding paragraphs upon which it is based. But the impression conveyed to this compiler was that the idea has not yet vitally entered into Navy thinking. On the contrary, the Navy's atomic bomb philosophy seems in its entirety to be based on the presumption that for as far ahead as we can see, the use of atomic bombs will be inhibited militarily by the requirement that "as nearly as possible every one must be delivered to its intended target."

Today the atomic bomb is apparently a commodity of great scarcity and very high unit cost. How long it is destined to remain so is a crucial but unsettled question. Various predictions pertaining to this question have been gratuitously offered to the public. Often such predictions emanate from persons whose competence seems impressive because of their former prominent place in the Manhattan District Project but whose function in that project was not necessarily such as to give them access to the pertinent facts. It may well be that some of the data essential to an accurate prediction are known only to God. But there are mortals who happen also to be Americans who do know how many bombs are being produced currently and who have some idea as to how much that production could feasibly be expanded should occasion arise.

The public knows only that fissionable materials can be more or less indefinitely stored and thus accumulated, and that the amount of available uranium and thorium in the world seems fairly extensive. It has reason to believe that the plant devoted to atomic bomb production could be greatly expanded if desired.

What one would have to know to forecast the upper limits of atomic bomb production for the United States over a given time period are basically the following three items:

1. the availability of raw materials and the factors governing availability,
2. the amount of pure U-233, U-235, or Pu-239 extractable with reasonable efficiency from a given weight of uranium and/or thorium, and
3. the minimum efficient amount of purified fissionable materials necessary for a bomb.

All these data are still highly secret. So long as they remain so, we lack any solid basis for criticizing the views entertained by the Navy in common with the other armed forces. But we are entitled to the opinion that the Navy's atomic bomb philosophy as outlined in the preceding pages *may* evaporate a good deal faster than the Navy expects.

The question of "how many bombs?" is relevant not only to speculation concerning the use of atomic bombs against a fleet but also to conditions at home which might affect the Navy. It is true that the Navy should not be obliged to base its planning on the assumption that the situation at home is one of complete catastrophe; but inasmuch as the Navy's functions as well as its ability to mobilize and to operate are intimately related to the maintenance of the integrity of the home front, one would expect naval leaders to take a great and active interest in the question of vulnerability control as concerns home industry and population. The information garnered by this compiler and presented in the preceding pages does not in itself wholly warrant the conclusion that the Navy is sufficiently and effectively interested in this problem.

QUESTIONABLE VALUE OF FIXED BASES

The question of "minimum necessary reliability" of carriers affects also the whole matter of advanced bases, either for defense against or attack with atomic bombs. Certainly bombers already exist (B-36) capable of 7,500 miles one-way range with atomic bombs. There would be little purpose in developing such planes unless one were considering their being used at very long ranges. And atomic bombs would have to remain exceedingly scarce to justify the conclusion that a plane reliable enough to carry ordinary bombs is not also reliable enough to carry atomic bombs.

3. Dr. J. Robert Oppenheimer, "Atomic Weapons and the Crisis in Science," *Saturday Review of Literature*, November 24, 1945, p. 10. One million dollars is considerably less than the cost of one fully equipped B-29, especially when one includes the cost of training the crew.

4. Bernard Brodie, in *The Absolute Weapon* (New York: 1946), p. 43. For an amplification of the ideas presented in the text above, see *ibid.*, pp. 40-9.

It seems to this compiler that the Navy greatly exaggerates the utility of fixed bases for the detection and interception of long-range bombers or even for ships bent on attack. The idea that such bases are not likely to be bypassed so long as they exist does not have substantial support in the experience of the recent war, including the attack on Pearl Harbor. So far as long-range bombers based on Europe and Siberia are concerned, bases for their interception would have to extend over a very wide arc indeed, and would have to be especially prominent in the Arctic. The Marianas bases and other bases in the Pacific and the Atlantic would simply not be in the picture.

REDISTRIBUTION OF FACILITIES

On the other hand, it must be stressed that the Navy's views on the indispensability of advanced bases as staging areas for *invasion* are quite irrefutable on the basis of known or presently conceivable techniques. During the recent war several invasions of hostile territories were sprung from bases as much as two thousand miles distant—in the case of the North African invasion from bases four thousand miles away. But these operations were in each case mounted against relatively weakly held enemy outposts, where enemy strength was either small in quantity or necessarily dispersed.

An effort on the scale of the Normandy invasion, however, could simply not have been launched from a base two thousand miles away. And even the Normandy operation was feasible only because far the greater part of the German Army was engaged in other parts of the Continent. To be sure, in both sea and (to a much lesser extent) air transport use of greater numbers of craft tends to compensate for greater distances to be covered, but the multiplication of numbers necessary for such compensation might easily put the end figure beyond the realm of possibility.

Among the questions which might very well be put to the Navy is: "How long is fifteen years?" The emphasis which that service places upon the needs of today as distinct from those of fifteen years hence is a valid one. Even when one expects an ultimate break in the market, one wishes not to sell it short too soon. But the needs of fifteen years hence must surely require some measure of planning *now*. For example, the Navy itself asserts that its larger bases represent by the concentration of facilities within them points of vulnerability.

Is it too soon now to begin an intensive study of how those facilities might be redistributed? Has such a study actually been undertaken? Possibly it has, but the compiler was not informed of it. It may take a long time before we know definitely where we stand in regard to international control of atomic energy, and in any case some amount of reinsurances by diminution of vulnerability would offer a useful implementation and support to whatever international control system is set up. The situation will never again be what it was, regardless of what happens in the field of international control.

The same point is relevant also to the whole question of docking and port facilities. Not only do such facilities represent areas of crucial weakness as concerns the integrity of the domestic economy, but they affect also the whole issue of sending troops and supplies abroad for military operations on foreign soil.

FLEXIBLE PHILOSOPHY IS NECESSARY

Both the Navy and the Army rest their argument for continued preparation along traditional lines largely if not predominantly on the thesis that destruction from the air, however devastating, is in itself not enough; invasion and occupation are also necessary to consummate victory, or at least to wring from the enemy the acknowledgment of defeat. But how are mass armies and their even more massive equipment to be shipped from ports in which docks and railroad terminal facilities have been largely destroyed? The Navy recognizes that amphibious operations must be modified to permit a more thinly spread approach. Does not the same principle apply in reverse, at the point of embarkation? At least the subject is one deserving study, and the present can hardly be too soon to begin.

The most fundamental question of all is of course the degree to which the Navy can be depended upon to guarantee for itself that flexibility of philosophies which it now recognizes as of paramount importance for the future. All we have to go on in forming our expectations is the record of the past. That record is by no means wholly or even predominantly unfavorable as concerns readiness to adapt to new conditions. The United States Navy has in fact led in important new developments, such as dive bombing and the dropping of torpedoes from aircraft. During the recent war its technical equipment and its handling of carrier operations proved far superior to that of all other navies. But instances of important failures to foresee the requirements of modern war are also in the record.

It is pertinent to point out that any military organization, especially after a great war which it has fought with brilliant success, tends to feel an enormous vested interest in the experience which it has acquired with so much pain and labor. It is not likely to feel spontaneous sympathy with the suggestion that that experience may be of very diminished applicability for the future. Comparable attitudes are universal among all men of whatever calling. There is thus warrant not for condemnation but for caution. The assertion "we must keep our philosophies flexible," however sincerely intended, must be accepted as an expression of hope rather than a promise.

Critique of Army Thinking

The portion of the Critique that follows applies to Part V of "Army Thinking On The Atomic Bomb" published in the June issue of the BULLETIN.

This is probably the most important section of the paper and certainly the one where we are most entitled to expect specific conclusions concerning policy. The basic points made in the opening paragraphs are:

1 continuing research and development in the field of military weapons are of paramount importance for our national security;

2 the development of the atomic bomb and of long range aerial vehicles to carry it makes it necessary that our military establishment in being at the onset of hostilities be ready and able to fight a war rather than merely to provide a framework for post-hostilities expansion; and

3 the forces in being must be highly mobile in order to permit keeping their numbers to a reasonably

low figure and they must be well-balanced in terms of components.

Here again one cannot logically take exception to any of these points, but many questions may appropriately be asked because of the vague manner in which these principles are presented and the absence of any indication of how the Army proposes to implement them.

Concerning the first point, for example, one would like to know whether in fact the Army is guided by the doctrine of "research above all" in preparing its own budgetary requirements. On the third point, concerning the "balanced" combat force, the Committee may wish to ask: "balanced in terms of what?" A force which is balanced for one kind of warfare is hopelessly unbalanced for another kind. The term "balanced force" has tended to become a military shibboleth, too often used simply to beg the constantly recurring question: "What is the proper composition of our military establishment?" A single sentence which merely lists the conventional components of modern military establishments does not reflect the magnitude of the analytical problem.

These general principles stated, if they have meaning at all, are revolutionary in the extreme and imply gigantic problems of reorganization. It is definitely not indicated how the Army proposes to proceed towards their implementation.

DEFENSIVE ASSUMES NEW IMPORTANCE

Quite noteworthy, on the other hand, is the statement that despite the Army's continuing devotion to the "principle of the offensive," it is now clear that we must devote a higher percentage of our national resources than ever before to defensive measures—if only to guarantee our ultimate ability to take the offensive. Equally significant is the recognition that since it is politically and economically unfeasible to retain in being forces sufficient to discharge all requirements of an atomic war, "there remains a vital need for rapid mobilization of manpower as well as industry."

In other words, if we cannot rely on a mobilization process on the World War II pattern, neither can we rely wholly on the stockpiling of military personnel and equipment. Some compromise must be found.

On the question of the dispersion of population and industry, the Army concludes that the "pattern of U. S. life, social and industrial, will never permit the degree of dispersion which military strategy makes desirable." That is a realistic recognition of circumstances far beyond the Army's capacity to alter. The conclusion suggests the selection of "those facilities absolutely essential to our fight for survival" in order that these at least could be dispersed or otherwise protected. And, "in addition to limited dispersion we must effect substantial stockpiling."

DISPERSAL OF ESSENTIAL FACILITIES

Here again we have the statement of a problem of Gargantuan proportions. Before our armed forces can determine and make affirmative recommendations to Congress concerning just what facilities are essential to our fight for survival *in an atomic war* and just what ought to be stockpiled, they must analyze the peculiar requirements of atomic warfare precisely rather than in broad generalizations.

Following that or preferably running concurrently with it, there will have to be an elaborate survey of American industry to indicate what ought to be moved and where, and what ought to be stockpiled. None of these things can be done overnight. Congress may wish to assure itself that programs to accomplish these ends are effectively under way; and, if not, whether they are being planned.

The section on "military requirements" concludes with a timely reminder that there are many duties and responsibilities now reposing on the American armed forces which are affected little, if at all, by the atomic bomb—such as the occupation of defeated enemy countries and the fulfillment of our commitments under the United Nations Charter. It also points out quite justly that the very existence of her military strength as evidenced by conventional forces in being considerably contributes to the security of the United States. This reflects the reasonable conclusion that American military forces are not necessarily more conservative than those of other nations, and if we want to be sure to impress all interested observers with our strength we must be strong in all departments, including the old as well as the new.

In the last-paragraph-but-one of the paper the question is raised whether the atomic bomb can achieve a decision by itself. "The certainty that it can," the paper reads, "has yet to be demonstrated." It would be as logical and as true to substitute for the word "can" the word "cannot"—i.e., "the certainty that it *cannot* has yet to be demonstrated." What is implied in the term "by itself?" But there is no need to favor either slant.

Just how decisive the atomic bomb will be in a future war is not definitely known at present. Some of the essential data for making even a good informed guess are not publicly available, above all the data which would enable one to estimate within reasonable limits how many bombs a country like the United States *could* produce if it put a really serious effort into it over a period of say ten years. For it should by now be obvious that the numbers of bombs used and the tactical circumstances governing their delivery will be the chief determinants of the character and the outcome of any war in the future. The number of bombs used is a far more important consideration than the possible increase in power of the individual bomb.

ELASTICITY OF THOUGHT

The War Department paper does not materially assist in the advancement of thinking on the military impact of the atomic bomb. Most of the conclusions and deductions contained in it are to be found in earlier writings available to the public. That fact in itself is of no moment if the Army has earnestly engaged itself with the task of refining the conclusions which it has accepted and of laying plans for the implementation of the policies indicated by those conclusions. Congress may wish to assure itself of an answer to this question.

The implications of the arguments advanced in the War Department paper are revolutionary in the extreme, and the presentation therefore argues an elasticity of thought and a readiness to consider new ideas—something which clearly deserves due credit. There is a commendable minimum of visible attachment to the *status quo ante Hiroshima.*

THE ROLE OF BIOLOGISTS IN WARFARE

Kenneth V. Thimann

*This general survey of the work of biologists during the war is based on a lecture given to the Association of Cambridge Scientists in April 1947. Professor Thimann teaches plant physiology at Harvard University. He is well known as a contributor to the knowledge of plant growth hormones which laid the foundation for the wartime development of plant killers such as "2,4-D".**

It is commonly said that biologists were not effectively used during the last war. This is not entirely true, for many biologists played useful roles although not engaged in biological warfare itself. Many, for instance, worked in their minor fields of competence, usually as chemists or physicists. Quite a number, particularly in England, found a niche in Operational Research. This work consists of the analysis of the general effectiveness of Army or Navy operations, which commonly are more or less standardized procedures repeated very frequently but under differing conditions. This gives them considerable similarity to biological experiments and in many respects, therefore, military results and data are like those of biology and agriculture.

Many biologists, of course, worked on problems of a more or less biological nature which were raised by our war operations. There were the problems related to the preservation and drying of food, and the deterioration of various kinds of supplies under field conditions. Deterioration became a very serious matter in the tropical jungles of the Pacific theater and masses of valuable instruments and equipment were made useless in a few weeks through the inroads of fungi. A few worked on problems of camouflage, such as the proper use and preservation of living plant material, and the imitation of chlorophyll or of natural patterns for protective purposes.

Another large group of biologists were employed on problems relating to personnel. These included, of course, many of a largely medical nature, such as the treatment of burns and shock and of battle fatigue. There were also, however, many fields of physiology developed. The effects of high altitudes have been much studied in the past in connection with the solubility of gases in blood and this work was extended to cover the various effects of reduced pressure on the senses, the effects of sudden changes in pressure and of high accelerations —the "g" effects. A similar group of problems exists for submarine personnel, particularly the effects of rapid changes in pressure and the conditions leading to bubble formation in blood, as well as the influence of relatively high CO_2 tensions. The introduction of the Schnorkel in German U-boats sometimes led to an increased CO tension in the boat, and this, had the war progressed, might well have led the enemy into wider investigations of CO tolerance and related problems. An enormous amount of research on the biochemistry of blood and blood proteins was carried out, much of it here at Harvard, and this program has had a large effect on medical and surgical practice. Problems of this type obviously overlap into the field of medicine, and it is not my intention to discuss here the very large and fruitful body of medical research sponsored by the services and particularly by the Committee on Medical Research of the National Research Council.

OFFENSIVE VS DEFENSIVE PSYCHOLOGICAL ATTITUDES

All of the above may be considered as more or less conventional applications of biology to military problems. The psychology involved is essentially a defensive one, since the problems dealt with are largely those which were thrust upon us through the pressure of our war operations. The offensive psychological attitude is based on the realization that man is a living organism and feeds on living organisms, so that both he and his diet can be attacked by biological methods, just as they are in nature. Our own work in this field seems to have arisen primarily from the idea of defense against possible biological warfare employed by the enemy, but it was by no means only defensive in its nature. It can be divided into two main groups, though these are of course interrelated at many points.

I. THE ATTACK ON MAN

It has often been stated that in past wars disease has caused many more casualties than military weapons themselves. Evidently, therefore, war could be waged by spreading disease. Pathogenic bacteria could be sprayed on the enemy in various ways, in missiles or from the air. Cholera, dysentery and bubonic plague would be obvious choices for such a campaign. It is believed that considerable research was done on methods for large-scale production and handling of pathogens and for their dissemination in the air. The paramount requirement in such an event would be to prepare for the disease to spread back into our own ranks. For this purpose rapid diagnosis is essential, and the preparation of protective agents such as vaccines or antitoxins on a really large scale would require development. These factors also were studied intensively by biologists and there is reason to believe that some of the results will be published. In this connection, though, it is important to remember that we now possess many non-specific antibacterial agents such as the sulfa drugs, penicillin, and streptomycin, which might well make such a campaign less effective than it would have been in the past.

The recognition of the disease could be made more difficult by introducing a new mutant of it. Whether this has

*The author wishes to make it clear that he did not work on biological warfare proper and had no access to classified material on this subject.

been done is not known, but since x-radiation, ultraviolet and other treatments will readily induce mutation in micro-organisms, some such artificial modification of a disease might present new symptoms which would delay recognition (and therefore effective treatment) long enough to enable it to become well established.

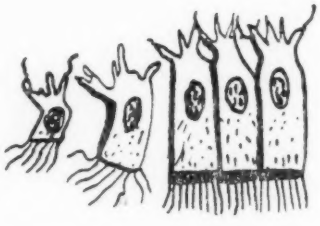
Another line which is known to have been studied is the use, not of the organisms themselves, but of their toxic products. A number of bacterial diseases are due primarily to toxins produced by the bacteria, and these toxins are probably the most virulent poisons known. That of diphtheria, which was prepared just before the war, had a minimum lethal dose, for a 250 gram guinea pig, of 0.1 gamma. This corresponds to 0.03 milligrams for man, and means that a pound of the material could kill thirteen million people. This compares very favorably with the lethality of atomic explosives, but of course such a figure could not be achieved in practice since it would require injection into each individual. The material would have to be scattered in some way, perhaps as a mist, and its effectiveness would be far lower. The toxin of botulism, produced by *Clostridium botulinum* type A, was isolated by the biological warfare group, and its lethality is believed to be higher than that of the diphtheria toxin.

Some important non-biological toxins have also been brought out by the war, particularly fluoracetate and difluorophosphate, which act by interfering with steps in the metabolism of carbohydrates, and are excessively poisonous to animals.

II. THE ATTACK ON FOOD

The U-boat campaigns of World Wars I and II were in good part an attack on food supplies, and as is well known, they were in each case quite successful for a time. Biological attack on crops and farm animals might well be more successful, but only in a war of some length, since major nations usually carry extensive stocks.

Considerable work has been done, both by military and non-military agencies, on defoliating agents and plant-killers or herbicides. The dichlorophenoxyacetic acid or "2,4-D" now being widely sold as weed-killer is the best example of this. Over one thousand related compounds were made and tested by the biological warfare group and this work has been published in detail. Such substances are essentially synthetic imitations of the plant's own growth hormones or auxins, and they have the advantage over other types of herbicide (such as arsenic or sulfuric acid) that they are readily transported from one part of the plant to another. Spread at the rate of 1 to 2 pounds per acre they will kill a wide variety of plants including many important crop plants. Here no injection, but simple spraying, is sufficient, so that large acreages could be destroyed efficiently from the air. Cereal crops were found to be resistant. However, another group of substances, of which isopropylphenylurethane is the best example, are effective against barley, oats and some other cereals. It is worth noting that in many climates destruction of the young growing crop would make it impossible to harvest a second one before the end of the season.



Crops may also be attacked biologically, using the natural pathogens, against which war is always being waged in agricultural experiment stations. The wheat rusts, for instance, often cause huge damage because the rust spores from Mexican wheat get blown north to the United States and even to Canada, or vice versa. A good part of the "war" against such parasites is waged by developing resistant forms of the crop plant, but here again mutants might be effective. There are many possibilities to be selected from the long list of plant diseases; leaf-spot on rubber, carefully quarantined from southeast Asia; wilt of coconuts, a widespread disease already in some parts of the tropics; and ergot of rye and wheat, an infection which also makes the parasitised ears highly toxic to man and animals, as evidenced by numerous outbreaks of "ergotism" in the past. All these diseases, being fungous in origin, spread best in wet weather, so that their effectiveness in any given climate would not always be reliable.

DISEASE SPREAD EASILY; DIFFICULT TO TRACE

Diseases of farm animals can also be easily spread. There is a highly fatal cattle plague called "rinderpest", on which much work was done jointly by the United States and Canadian biological warfare groups. Since this is a virus disease, the vaccine can only be prepared by cultivating the virus in living tissue of susceptible hosts. Although such a vaccine can be prepared from infected cattle, it was found in the course of the work that the virus could much more conveniently be carried in developing hen's eggs, and that in so doing it became modified enough to produce only slight symptoms in cattle but yet to confer full protection on them. The use of cowpox as a vaccine against human smallpox is, of course, the classical example of this sort of phenomenon. This work will have most important peacetime applications, especially in the Orient where rinderpest is a very serious disease.

It is hardly necessary to point out that at least some of this work can be carried out on a relatively small scale. It does not require a Hanford or an Oak Ridge to manufacture major quantities of pathogens or their products. Correspondingly the number of biologists employed on such projects during the war was by no means large. Thus, in any system of international inspection it would be difficult to trace either the personnel or the institutions involved. For these reasons, as George Merck has pointed out, "there should be careful and serious consideration of the subject in whatever deliberations take place concerning the implementation of a lasting peace in the world."

The above is not intended to be, nor indeed could it possibly be, a complete account. It is intended only as a survey of some of the results and a suggestion of the possibilities. There can be no doubt that the implications are very great.

UNITED NATIONS ATOMIC ENERGY NEWS

Peter Kihss

The BULLETIN is pleased to offer this first-hand report of events at Lake Success as a regular monthly feature. Mr. Kihss, a staff member of the NEW YORK HERALD TRIBUNE, has specialized in Atomic Energy Commission activities.

The two rival views facing the United Nations Atomic Energy Commission were focused more sharply this past month.

Since the last BULLETIN, Andrej A. Gromyko has presented Soviet control proposals in a positive form, as provisions to be embodied in a separate convention, following an initial convention on outlawing atomic bombs. The Soviet would rest control chiefly on international inspection.

The majority plan, embodied in the first commission report, had its first considerable extension since last December, with submission of the first five working papers on detailed aspects of the proposed international control agency. The introductory paper suggested that security and political considerations alike dictate the view that the basic treaty itself should specify output and mining policies.

May 28: The Working Committee held its third discussion of Soviet Amendment No. 2 to the first commission report, now reduced to the reaffirmation of the Assembly disarmament resolution statement that the atomic control system should be established "within the framework of the Security Council." Great Britain and Canada re-stated their opposition to any veto on the punishment of atomic violations, and insisted, with the United States, that the future world agency receive just as much power as could be agreed upon by the signatory nations.

May 29: The Working Committee unanimously adopted a resolution, saying it "adheres to taking for granted the principle as stated in the General Assembly resolution"—namely, that the atomic system be established within the Security Council framework, operating through special organs deriving their powers and status from the conventions under which it was created. The United States joined ten others in voting for it (Colombia was absent), after Mr. Gromyko said the veto was not now at issue. The United States, Belgium, Brazil and Canada noted reservations to the same effect as an American amendment which had failed to poll the required majority — that the new resolution "in no way modifies the relevant portion of the first report."

INTERNATIONAL INSPECTION VS INTERNATIONAL MANAGEMENT

June 2: The Control Committee heard David E. Lilienthal, chairman of the United States Atomic Energy Commission, discuss the domestic commission and the Tennessee Valley Authority, for their perspective value in organization and staffing of the world agency. A condensed version of this statement appears elsewhere in this issue of the BULLETIN.

June 3: The Working Committee took up Soviet Amendment 3, revised to propose that a convention outlawing atomic weapons "must be complemented by" the establishment of a control system, "including inspection". Mr. Gromyko held "international inspection" would be "sufficient" to prevent production of atomic weapons, and ruled out such additional mechanisms as supervision, licensing, operation and ownership by the international agency. In the face of strong opposition to separating the outlawry and control agreements, he did not insist on a vote, but said the issue would have to be faced some other time.

June 4: The Control Committee received first four working papers, prepared by groups of delegates serving as individual experts and not yet committing their governments. These papers took up the functions of the future world agency in relation to (1) research and development, (2) location and mining of ores, (3) processing and purification of source material, and (4) stockpiling, production and distribution of nuclear fuels, and the design, construction and operation of isotope separation plants and nuclear reactors.

As submitted, these contained a number of alternative clauses, and none was made public, pending further discussion. Frederick H. Osborn, of the United States, said they carried a thesis now up for debate—"the thesis of the ownership, management and operation of dangerous atomic facilities by an international agency."

In the year since UN work began, he said, "Some ten, twelve or fifteen nations have set up national agencies to have exclusive charge of all atomic energy activities." The only alternative to international operation which had been talked about, he said, was the creation of an international agency to inspect operations of these national agencies, and to give them orders on what to do. He held any international agency giving orders to national agencies "would be in constant conflict with the national agency of every country," and believed this alternative so poor as to be "a fraud on the people of the world."

INTERNATIONAL OWNERSHIP DEBATED

"Under the first system of ownership," Mr. Osborn went on, "the nations would swallow hard once and give up their sovereignty in the field of atomic energy, by the signing of one treaty. Thereafter, there would be no longer any question of sovereignty involved, because the international agency would be giving itself orders with respect to its plants."

Sir George Thomson, of Great Britain, revealed that there was by no means a complete accord on how much the international agency needed to own, to assure complete control of, for example, mined ores. The ownership principle, he said, had not been discussed in any meeting of plenary bodies, and so far he was not authorized to accept it. Dr. Hsioh-ren Wei, of China, said China's position on ownership had not yet been decided. A coordinating group, composed of leaders of the working paper groups, was assigned to write

an introductory paper, including a discussion of the implications or justifications of ownership.

June 4: The Working Committee unanimously agreed by resolution to the principle contained in Soviet Amendment 4, to add a reference to the Assembly disarmament resolution to the introduction to the first report's recommendation, insofar as atomic energy portions of the Assembly document were concerned.

SOVIET PROPOSALS DISCUSSED

June 10: The Working Committee took up Soviet Amendment No. 5, which would provide for an atomic "convention" instead of "treaty or convention." It agreed on the principle of using the wording of the Security Council resolution on the first report—"treaty or treaties, or convention or conventions." The United States entered a reservation, saying it believed the commission had already decided there should be but one treaty or convention.

June 11: The first full commission session since March 19 heard Mr. Gromyko's statement on the Soviet plan for "basic provisions on which an international agreement or convention on atomic energy control should be based." The text appears separately in this issue of the BULLETIN. The tone was unusually mild, but analysis showed fundamental differences remained unchanged:

1. The Soviet would separate the problem into two parts—one, an immediate convention to outlaw atomic weapons; the other, a convention to set forth international controls. The majority prefers a single-package document.

2. The Soviet provides only for "recommendations to governments on the questions relating to production, stockpiling and use of atomic materials and atomic energy," thereby leaving operation to national auspices. The majority believes the international agency alone should operate dangerous atomic activities.

3. The Soviet provides only for "recommendations to the Security Council," in connection with violations, and thus leaves the great-power veto free to operate. The majority believes the veto should be barred in atomic affairs.

June 12: The Working Committee heard Mr. Gromyko argue that his new proposals should be referred mostly to the Control Committee. Mr. Osborn argued that the Soviet proposals should be taken up in the Working Committee, since they embrace a single unified scheme for control, and the Control Committee was working on a different scheme. Both schemes, he said, should be considered on their merits, and he did not want to interfere with the Control Committee's consideration of the working papers.

Favoring parallel discussion in the two committees, Alexandre Parodi, of France, said the commission now faced two possible systems of international control and inspection. The Soviet plan, he said, was more respectful of the sovereignty of states; it would be easier to put into effect, but less effective. The plan favored by the majority would be more effective but more difficult to put into effect, and it would also require that states make greater sacrifices. His delegation was not ready to accept any plan without finding out what it would have to sacrifice in sovereignty, and what safeguards would balance this sacrifice.

Mr. Gromyko termed absolutely wrong any supposition that would exclude the possibility of reaching agreement by combining the two plans. This statement was widely interpreted to indicate that the Soviet plan was not inflexible. But Mr. Gromyko also recounted a Russian fairy tale, about a fisherman and his wife, who found a magic fish, and received all their first wishes; the couple finally asked too much, and broke the spell, finding themselves standing forlornly before an old broken trough. He hoped the commission would not find itself some day before a broken trough.

RUSSIA FEARS "CAPITALIST INFILTRATION" — AUSTIN

June 13: Warren R. Austin, chief American representative, spoke at the Massachusetts Institute of Technology commencement. He said the Soviet Union was still rejecting the majority view on developmental and management functions of the proposed world agency, as well as enforcement methods, "apparently out of fear of capitalist 'infiltration' into Russia." He noted that the commission was studying specific proposals to implement the general principles on which the majority was agreed, and added: "When these proposals have been worked out —with their explicit safeguards to each nation, explicit recommendations on the rights of the control agency, explicit opportunities for application to the International Court, to the Security Council or to other agencies of the United Nations for redress of inequities in the operation of the system, it is our hope that the Soviet Union will come to realize that there is no secret or hidden danger to the Soviet state in the proposed system of control.

"We hope she will also see that the limitations on the sovereignty of each member nation that the majority believe are essential can be so applied that they will not operate to the disadvantage of any one system of government or way of life, but on the contrary, will make it possible for each nation to join in the peaceful development of atomic energy without fear of violation of its independence or of destruction by some future atomic aggressor."

June 14: The First Commission anniversary passed without observance. Mr. Osborn in an interview observed that "in a year, the Russians have made some very important concessions." He cited the acceptance of inspection by international personnel and of positive research functions for the world agency.

WORKING COMMITTEE AGAIN DEBATES VETO

June 17: The Working Committee decided to go ahead with Soviet Amendment No. 6, involving the veto issue, and to leave it open in the Control Committee to discuss those working papers and Soviet proposals falling within the scope of its program.

June 19: The Working Committee took up Soviet Amendment No. 6, which would delete the first report language banning the veto over obligations imposed by the treaty or over the course of control or inspection. The Soviet would provide that control and inspection be exercised on the basis of rules providing for decisions in the control organs, in appropriate cases, by majority vote. It would delete other report language dealing with the positive research and development functions of the agency. Mr. Gromyko said the veto should not apply to day-to-day activities of the control commission. But he said it was the Security Council which had the sole right to take measures to restore peace, and there the charter required the rule of great-power unanimity. On research, he inquired why the control agency should carry on

research for destructive purposes, if the intent was to ban production of atomic weapons. Australia and Brazil both spoke out sharply against any veto in atomic affairs.

CONTROL COMMITTEE HEARS DE ROSE PAPER

The Control Committee met, and Francois de Rose, of France, presented the introductory working paper, prepared by the coordinating group, consisting of himself; Dr. John E. Vance of the United States; Sir George Thomson, of Great Britain; General Andrew G. L. McNaughton, of Canada; and Dr. Wei, of China, all serving as individuals. Again this was not made public, but the following is a digest of its chief points:

Security is held to be the paramount requirement. Political considerations led to the finding that the control agency should not have power to decide certain major policy questions. These questions include stockpiling, production and distribution of fuels, which would alter the general conditions of world security. On these, the principles should be laid down in the basic treaty.

Non-dangerous developments should be allowed to nations, subject only to security regulation. Power production, in the present state of knowledge, is a dangerous activity, and must be in the hands of the international control organ.

The agency should be given flexibility to select safeguards, depending on the stage of development. Such flexibility applies mainly today to mining, purification and research, but may be broadened as developments occur.

The first report offers several possibilities on security—(1) full power to the agency to make decisions, (2) freedom to nations to make production decisions, or (3) some intermediate possibility.

On production, distribution and stockpiling of nuclear fuel, which is easily convertible to weapons, there might be large stockpiles even before the production of atomic power—for instance, in connection with isotope separation or power developmental work. Production rates might have a considerable influence on the possibility of atomic warfare. Distribution should be such as to minimize military advantages to a nation from seizure. Dangers are sufficiently great to warrant the statement that: if the right to decide the number and size of facilities were left to individual nations, control measures specified in the first report would not alone prevent the chance of potential military supremacy, or, through seizure, actual military supremacy, being attained by a nation or group of nations.

If decisions on the determination of mining quotas were left to individual nations, reserves might be retained in the ground, or stockpiles accumulated to the disadvantage of other nations, or large quantities of source material might be accumulated by a nation through purchase.

Therefore, these decisions on production, distribution and stockpiling on one hand, and mining on the other, cannot be left to individual nations, and, subject to certain conditions, should be assigned to the international agency.

But the agency also should not be allowed to conduct a free policy on the production and use of atomic energy. Principles governing such a policy should be decided by international agreement. Any proposal to leave those questions to be decided freely by the agency would be bound to encounter government refusal. Principles governing the agency's policy should be agreed upon by those nations whose signature and ratification would be necessary for the treaty to become operative, and modification of those principles should require agreement of the same nations. The treaty should make it mandatory for the agency to keep production of nuclear fuel at the minimum necessary for efficient operating procedures required in the beneficial uses of atomic energy, including research and development.

In the same way, the agency also should not be entirely free in determining mining quotas, and the treaty should embody the principle that comparable national deposits throughout the world would be depleted proportionately.

The agency must have the final right to decide the type and location of power reactors, subject to treaty provisions drawn up after discussion of the principles governing geographic location of dangerous facilities. When security is fulfilled, the agency should make atomic power available at the request of any nation which has economic need for such power, and is ready to pay the cost.

The agency should have research and development powers—to learn whether the regeneration of fuels is possible, to find the extent to which denatured fuels may be used and to be able to recognize clandestine operations. National research should be restricted only for security reasons, where dangerous quantities of materials are involved. Nations and persons should be banned from using nuclear fuel for the development, production or assembly of atomic weapons. The agency should encourage private and national research.

The ownership problem was left still controversial in the coordinating group's paper.

SKOBELTSYN TRIES TO STOP INFORMAL DISCUSSIONS

June 23: The Working Committee continued work on Soviet Amendment No. 6, with delegates observing that no one had suggested a veto on day-to-day operations. Mr. Gromyko proposed that if everyone was agreed on the meaning of that particular portion of the first report, the Committee might adopt a resolution: "The reference to the question of the veto contained in Paragraph 3-A of the first report of the Atomic Energy Commission should not be understood in such a way that it relates to the day-to-day operations of the international control organ. The questions on which the agency shall have power to take decisions shall be specified in the convention or treaty (conventions or treaties), as well as those on which the organ shall make recommendations to the Security Council, but not decisions." Syria objected that the first report section involved more than just day-to-day agency operations, and included the possibility of a Security Council veto obstructing measures agreed on by the agency. The Committee adjourned without agreement.

June 24: The Control Committee heard Professor Dmitri V. Skobeltsyn, of the Soviet Union, raise a number of questions on the coordinating group paper. In general, he held, informal working papers were not aiding progress, and he contended that the delegates were going beyond the Assembly's terms of reference. No longer were they talking about control, he said, but about "internationalization of atomic industry." The Soviet remains opposed to international operation. He hoped the delegates would soon get back to fundamental questions of control, and objected to informal talks, which were not binding on any government.

SCIENTISTS RE-DEFINE

A year has passed since the founding of this Committee and the publication of our first appeal to reason in the face of the overwhelming threat presented to civilization by the atomic bomb. During this year our hopes for international agreement on control of atomic energy have come to nothing. It is imperative that the American people understand this failure if any constructive solutions are to be arrived at in time.

Can thoughtful and well-informed men any longer expect fruitful agreements to come out of the discussions now going on in the United Nations Atomic Energy Commission? Are the American proposals for the international control of atomic energy fair? Are the Russians to blame that any agreement is further away than at the initiation of the discussions?

These are questions of varying degrees of importance but the imperative question, the answer to which is a matter of historic necessity, is: "How can we reach a world consensus to abolish in the near future the threat of atomic war, and ultimately, the possibility of war itself?" If we fail to find the answer to this question, the answer to any other question is irrelevant.

All signs indicate that we are failing to meet the challenge. Peoples throughout the world want peace as never before, yet nations prepare feverishly for war. Preparation goes on day and night on both the material and psychological planes. Instead of the "One World" which men proclaimed a few short years ago, we have come even to the partition of existing nations. The United Nations, in which was invested the hopes of peoples throughout the world, is granted inadequate powers and, indeed, this tribunal is bypassed on matters of primary importance. Militarism is rampant throughout the world. In all history, never in any period of "peace" have so many men been under arms. Even in Great Britain and America with their great anti-militarist traditions, liberal-thinking men, considering the necessities of the situation, turn to the "realistic" solution. The Prussian disease of which the German and Japanese states have died is beginning to infect the conquerors.

Events during the past year have emphasized the tragic pertinence of our Six Point statement published on November 17, 1946:

1. Atomic bombs can now be made cheaply and in large number. They will become more destructive.

2. There is no military defense against atomic bombs and none is to be expected.

3. Other nations can rediscover our secret processes by themselves.

Statement of the Emergency Committee

This statement of the Emergency Committee of Atomic Scientists, issued on June 29, inaugurates its second year of existence. The crisis created by the unsatisfactory progress of negotiations for international control of atomic energy led to a call for re-definition of the scientists' educational program. The "Lake Geneva Statement", on the opposite page, is a response to this call, re-creating a basic unity of purpose. The Emergency Committee endorses this statement and indicates here the wider scope of its future educational campaign and initiates a new drive for funds for continued support of the educational activities of the scientists.

4. Preparedness against atomic war is futile, and if attempted will ruin the structure of our social order.

5. If war breaks out, atomic bombs will be used and they will surely destroy our civilization.

6. There is no solution to this problem except international control of atomic energy and, ultimately, the elimination of war.

Once stockpiles of atomic bombs have been accumulated by two national blocs of a divided world, it will no longer be possible to maintain peace. Thus we have one year less to secure a workable solution to safeguard our civilization.

Why have the year-long discussions in the United Nations Atomic Energy Commission not succeeded? Is this because of incidental and transitory factors which can be remedied by simple measures such as, for instance, the appointment of new personnel to carry on the discussions? The answer is in the negative. The representatives of great states while striving to safeguard the peace, have fulfilled their traditional duty to place their own nations in the most advantageous position to win the next war. It is useless to proceed further along this path; one cannot prepare for war and expect peace.

This is not to say that war is inevitable. It is to say, however, that the discussions now under way may not make a war less likely, and, in fact are based upon the premise of an anticipated war. What is necessary at this critical time is to determine whether there remains an alternative approach more likely to achieve peaceful solutions.

We believe that there is such an alternative approach. We believe that the problem of atomic energy can no longer be treated as an isolated issue. We had hoped a year ago to achieve a pattern of international control of atomic energy which could be applied to other spheres of international concern to implement the creation of a stable world society. To foster this hope today as we move into a world divided into two armed camps would be a betrayal of our responsibility.

We believe that the imperative problem of international control of atomic energy must be solved and can only be solved within the context of a general agreement which guarantees a reasonable degree of security to all nations and provides for far-reaching economic and cultural cooperation among nations. Such a settlement is not possible if the respective peoples are concerned exclusively with the security and welfare of their own countries.

Because of the importance of the United States in the world today it is imperative that the American people take an active part in achieving such a world settlement. America must be prepared to mobilize her vast resources on an adequate scale to help the peoples of the world lift the levels of their economic life. All peoples would be expected to make reciprocal sacrifices to achieve great ends. Only bold measures of this kind can produce an atmosphere between nations which makes it possible to discuss constructively the restric-

EDUCATIONAL AIMS

I

As scientists, we possess a professional knowledge of the developments of science, and in particular, of the peaceful and military possibilities of atomic energy, with its great consequences for good and evil.

The universal character of science, which has created a world-wide scientific community implies to us the probability of discoveries of the same scope in other parts of the world.

We believe that our knowledge imposes on us the responsibility of providing our fellow countrymen and the world with information necessary for charting a wise policy.

The tradition of science involves the seeking of relevant facts and the testing of conclusions in the light of these facts. We believe that by communicating this attitude of science to our people and their leaders we may assist in some measure in the solution of the political problems which have arisen and will continue to arise from the advance of science and technology.

II

We believe that the difficulties encountered in the present attempts to arrive at an agreement on international control of atomic energy do not release us of our responsibility but make it all the more urgent.

We therefore reaffirm the following as our special responsibilities:

1. We will continue to make clear that the American monopoly of the atomic bomb is temporary, that there is no "secret" of the atomic bomb, and that there will be no defense which could save this country from ruin in a war with the new weapons of mass destruction.

2. We will continue to urge the establishment of an effective international agency for the control of atomic energy. We believe that control based on cooperative development of atomic energy offers the greatest hope for the future and that such control can and should be established without impairing the diverse economics of the individual nations.

3. We will work toward the extension and international distribution of the peacetime benefits of atomic energy, particularly those which will come from the application of new tools of research.

Statement of the Lake Geneva Conference

We print on this page a statement adopted unanimously by a three-day conference which included members of the Federation of American Scientists, the National Committee on Atomic Information, the Association of Scientists for Atomic Education, and several social scientists, at Lake Geneva, Wisconsin, June 18 through June 21. This conference was called by the Atomic Scientists of Chicago at the request of the above scientist groups to elaborate a new program for the activity of scientists in the light of recent international developments. It has shown that a wide area of agreement exists among scientists on the appraisal of the present world situation and the general aims of further action.

4. We will continue to point out the dangers to the progress of science, the freedom of scientists, and the civil liberties of citizens which arise from military control of science or its subordination to military aims.

5. We believe that scientific and technical considerations are becoming increasingly important in the determination of American policies, and we propose to appraise such policies on the basis of the attitude and information held by scientists.

III

The progress of present plans to avoid an atomic armaments race has been slow and uncertain. Considerations of alternatives and the possibilities of merging the present plans in more comprehensive schemes of world cooperation has become necessary.

Unless agreement on some plan embodying effective international control of atomic energy is reached, an atomic armament race will become unavoidable. It will inevitably bring pressure for the United States to embark on a "preventive" war. Such a preventive war would be an act of aggression and would not be justified on moral grounds. It would entail a bitter struggle, enormously costly in life and property, with unpredictable risks for the United States.

As scientists we claim no special competence in the fields of economics and international relations. We have come, however, to recognize during the last year that the problems of atomic energy cannot be dissociated from general progress toward cooperation among nations.

We recognize that our purpose—which is the permanent elimination of war—requires the establishment of a government of the world with powers adequate to maintain a peace based on the rule of law.

We believe it our obligation to join with other citizens in urging that the United States should participate actively in the development of instruments of world collaboration and use fully the agencies of the United Nations. We believe that it is urgent that the United States, which is the wealthiest nation in the world and has been little affected by the ravages of war, should make a great contribution, even at the cost of substantial sacrifice, to a program of world economic reconstruction under the auspices of the United Nations.

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tions on national sovereignty necessary to the preservation of peace.

But the American people should understand that there is no easy path to the accomplishment of these great objectives; that, in the long run, the creation of a supra-national government, with powers adequate to the responsibility of maintaining the peace, is necessary.

Is this realistic? We believe that nothing less is realistic. We know that the developments of science and technology have determined that the peoples of the world are no longer able to live under competing national sovereignties with war as the ultimate arbitrator. Men must understand that the times demand a higher realism which recognizes that "no man is an island", that our fate is joined with that of our fellowmen throughout the world. We must contrive to live together in peace even if at the cost of great material sacrifice, the alternative is the death of our society. As we approach what may be the last hour before midnight, the challenge is plain before us. What will be our response?

PROMINENT BRITONS URGE ATTLEE TO CALL BIG THREE MEETING

*The following three documents, published here in full for the first time, consist of: first, a statement issued in March requesting that Mr. Bevin raise the subject of international control with Marshal Stalin and General Marshall during the Moscow Conference. (This statement was issued by the Parliamentary Atomic Energy Committee sponsored by the New Commonwealth. It was signed by a large number of members of Parliament of all parties and by leading atomic scientists.) Second, Prime Minister Attlee's reply. Finally, a second statement issued in May urges again the need for a Big Three meeting to break the deadlock.**

1. We believe that unless, within the very near future, strict international control over atomic energy is established, we shall face a desperate world situation.

2. Statements by the Big Three Powers on this issue do not disclose any differences of principle which are necessarily insoluble. The principle of international inspection, unhampered by the veto, has been accepted by Russia. Further, the report of the Scientific and Technical Sub-Committee of the United Nations Atomic Energy Commission, composed of leading scientists of 12 countries, has shown that international control is a practical possibility. The discussions in the Commission and in the Security Council reveal that the issues dividing the Powers have been narrowed to three, viz.,

(a) The time at which the pact prohibiting the manufacture of atomic weapons shall become operative.

(b) The timing and nature of the stages whereby the international authority is to take over the control of the raw materials and atomic energy plants from national authorities and

(c) The question of whether the measures to be taken by the Security Council against violators of the control plan shall be subject to the Big Power veto.

We believe that these differences can be resolved by the negotiation of a comprehensive plan, which in addition to banning atomic weapons from national armouries, establishes an International Atomic Authority, defines its powers of control and inspection, and specifies in advance the timetable for the assumption of these powers. This master plan should be embodied forthwith in an International Atomic Convention and we believe that in such negotiations even the issue of the veto on sanctions, seen in its proper perspective, can be made the subject of compromise.

3. What is most needed at the moment is the overriding urge and will to obtain agreement at all costs and within the shortest time, on a plan for control which can be imposed throughout the world.

We strongly urge the Foreign Secretary to raise this vital issue with Generalissimo Stalin and General Marshall in Moscow as we believe that its settlement would greatly facilitate the solution of all the other outstanding international problems.

PRIME MINISTER ATTLEE REPLIES

10th April, 1947

My dear Blackburn,

The statement on International Control of Atomic Energy drawn up by the Atomic Energy Committee of the New Commonwealth Group, which you sent me on March 7, has been carefully considered by Sir John Anderson's Advisory Committee on Atomic Energy.

I fully agree with the emphasis laid in the statement upon the importance of establishing, as soon as possible, a strict international control of atomic energy. At the same time I feel that in its analysis of the points of difference which now divide the Big Three Powers on this subject, the statement is somewhat optimistic. It is said, for example, that the principle of international inspection unhampered by the veto has been accepted by Russia. It is true that some ground for this view might be found in the statements of M. Molotov in the debates leading up to the Resolution passed by the General Assembly on December 14, 1946, on disarmament. Since then, however, the speech made by M. Gromyko in the Security Council on March 5, 1947, has made it abundantly clear that the Soviet Government would only accept the principle of international inspection if the powers and functions of the international authority in the respect were confined within narrow limits. It also seems optimistic to describe as minor issues the three points of difference set out in paragraph 2 of the statement, including as they do the question of the veto, on which there is a wide divergence in the United Nations Atomic Energy Commission.

I am, however, in general agreement with the suggestion in the memorandum that our object should be to negotiate a comprehensive plan, which besides banning atomic weapons, would establish an international authority, define its powers of inspection and control, and specify, in advance, a timetable for the transfer to the authority of those powers. If this is to be done the right course seems to be to postpone any discussion of the issue of the veto until the details of the system of control have been worked out more fully. The question of enforcement can then be considered on a more general plane, as part of the wider problem of devising safeguards for the carrying out not only of this but also of other international agreements in the field of disarmament.

This method of procedure—the negotiation of a comprehensive plan and the postponing of discussion on the veto to a later and more general phase—is, in fact, the policy which our representative has advocated in the Security Council and the Atomic Energy Commission. It is expected that the Commission will now continue its discussions on these lines.

I feel sure that the best hope is to concentrate our efforts on the further discussions which are to take place in the Commission, and that it would not be appropriate that the

(*Continued on Page* 220)

*This statement was signed by Brig. Gen. Sir George Cockerill, Mr. Garner Evans (Secretary), Prof. H. S. W. Massey, F.R.S., Hon. Harold Nicolson, Prof. M. L. Oliphant, F.R.S., and the following members of Parliament: Raymond Blackburn, Robert Boothby, Donald Bruce, Seymour Cox, Rt. Hon. Clement Davies, Eric Fletcher, David Grenfell, D. L. Lipson, Commander A. H. P. Noble, A. M. F. Palmer, Rt. Hon. Sir Arthur Salter, and Wing Commander E. A. A. Shackleton.

SOVIET PROPOSALS FOR ATOMIC ENERGY CONTROL

Andrej A. Gromyko

The full text of the statement made by Mr. Gromyko on June 11 before the United Nations Atomic Energy Control Committee is given here.

Almost a year and a half has passed since the adoption by the General Assembly of the resolution on the establishment of the Atomic Energy Commission. Six months have passed since the adoption by the United Nations of the resolution on principles governing the general reduction and regulation of armaments, in which the task of the prohibition of atomic and other major kinds of weapons adaptable to mass destruction has been set forth as one of the most important objectives. Meanwhile, one must say frankly that the Atomic Energy Commission has not made due progress in its work.

The situation has not changed substantially, even after the consideration by the Security Council of the so-called first report of the Atomic Energy Commission, which, as is well known, was not accepted by all the States represented on the Commission.

It is time to proceed to the solution of concrete tasks confronting the Security Council, and the Commission, acting under its direction, must proceed with the establishment of international control of atomic energy, beginning with the most important of them. Avoiding the solution of such tasks, of course, cannot bring anything good, and only jeopardizes the whole idea of international control of atomic energy, as well as the decisions adopted by the United Nations to this end.

The Government of the Union of Soviet Socialist Republics will continue to insist in the future as well that the tasks set forth by the United Nations on the prohibition of atomic and other kinds of weapons of mass destruction should be considered from the point of view of the necessity of their solution without delay, and with this purpose in mind will continue to do its best in order to translate the adopted decisions into the language of practical action.

The Government of the Union of Soviet Socialist Republics, in addition, and in development of its proposal on the conclusion of an international convention on the prohibition of atomic and other major weapons of mass destruction, submitted for the consideration of the Atomic Energy Commission on June 19, 1946, presents for the consideration of the above-mentioned commission the following basic provisions on which an international agreement for convention on atomic energy control should be based:

BASIC SOVIET PRINCIPLES FOR CONTROL PLAN

1. For insuring the use of atomic energy only for peaceful purposes, in accordance with the international convention on the prohibition of atomic and other major weapons of mass destruction, and also with the purpose of preventing violations of the convention on the prohibition of atomic weapons and for the protection of complying states against the hazards of violations and evasions, there shall be established strict international control simultaneously over all facilities engaged in mining of atomic raw materials and in production of atomic materials and atomic energy.

2. For carrying out measures of control of atomic energy facilities, there shall be established within the framework of the Security Council an international commission for atomic energy control, to be called the International Control Commission.

3. The International Control Commission shall have its own inspectorial apparatus.

4. Terms and organizational principles of international control of atomic energy, and also composition, rights and obligations of the International Control Commission, as well as provisions on the basis of which it shall carry out its activities, shall be determined by a special international convention on atomic energy control, which is to be concluded in accordance with the convention on the prohibition of atomic weapons.

5. With the purpose of insuring the effectiveness of international control of atomic energy, the convention on the control of atomic energy shall be based on the following fundamental provisions:

(a) The International Control Commission shall be composed of the representatives of states members of the Atomic Energy Commission established by the General Assembly decision of January 24, 1946, and may create such subsidiary organs which it finds necessary for the fulfillment of its functions.

(b) The International Control Commission shall establish its own rules of procedure.

(c) The personnel of the International Control Commission shall be selected on an international basis.

(d) The International Control Commission shall periodically carry out inspection of facilities for mining of atomic raw materials, and for the production of atomic materials and atomic energy.

6. While carrying out inspection of atomic energy facilities, the International Control Commission shall undertake the following actions:

(a) Investigates the activities of facilities for mining atomic raw materials, for the production of atomic materials and atomic energy, as well as verifies their accounting.

(b) Checks existing stocks of atomic raw materials, atomic materials and unfinished products.

(c) Studies production operations to the extent necessary for the control of the use of atomic materials and atomic energy.

(d) Observes the fulfillment of the rules of technical exploitation of the facilities prescribed by the convention on control, as well as works out and prescribes the rules of technological control of such facilities.

(e) Collects and analyzes data on the mining of atomic raw materials and on the production of atomic materials and atomic energy.

(f) Carries on special investigations in cases when suspicion of violations of the convention on the prohibition of atomic weapons arises.

(g) Makes recommendations to governments on the questions relating to production, stockpiling and use of atomic materials and atomic energy.

(h) Makes recommendations to the Security Council on measures for prevention and suppression in respect to violators of the conventions on the

prohibition of atomic weapons and on the control of atomic energy.

7. For the fulfillment of the tasks of control and inspection entrusted to the International Control Commission, the latter shall have the right of

(a) Access to any facilities for mining, production and stockpiling of atomic raw materials and atomic materials, as well as to the facilities for the exploitation of atomic energy.

(b) Acquaintance with the production operations of the atomic energy facilities, to the extent necessary for the control of use of atomic materials and atomic energy.

(c) The carrying out of weighing, measurements and various analyses of atomic raw materials, atomic materials and unfinished products.

(d) Requesting from the Government of any nation, and checking of, various data and reports on the activities of atomic energy facilities.

(e) Requesting of various explanations on the questions relating to the activities of atomic energy facilities.

(f) Making recommendations and presentations to governments on the matters of the production and use of atomic energy.

(g) Submitting recommendations for the consideration of the Security Council on measures in regard to violators of the conventions on the prohibition of atomic weapons and on the control of atomic energy.

8. In accordance with the tasks of international control of atomic energy, scientific research activities in the field of atomic energy shall be based on the following provisions:

(a) Scientific research activities in the field of atomic energy must comply with the necessity of carrying out the convention on the prohibition of atomic weapons and with the necessity of preventing its use for military purposes.

(b) Signatory states to the convention on the prohibition of atomic weapons must have a right to carry on unrestricted scientific research activities in the field of atomic energy, directed toward discovery of methods of its use for peaceful purposes.

(c) In the interests of an effective fulfillment of its control and inspectorial functions, the International Control Commission must have a possibility of carrying out scientific research activities in the field of the discovery of methods of the use of atomic energy for peaceful purposes. The carrying out of such activities will enable the commission to keep itself informed on the latest achievements in this field and to have its own skilled international personnel, which is required by the commission for the practical carrying out of the measures of control and inspection.

(d) In conducting scientific research in the field of atomic energy, one of the most important tasks of the International Control Commission should be to insure a wide exchange of information among nations in this field and to render necessary assistance, through advice, to the countries' parties to the convention which may request such assistance.

(e) The International Control Commission must have at its disposal material facilities, including research laboratories and experimental installations necessary for the proper organization of the research activities to be conducted by it.

In conclusion, I wish to express the hope that these proposals would be considered by our commission with due attention and that they will help us in reaching an agreement on the question of the establishing of international control of atomic energy.

Prominent Britons Urge Big Three Meeting

(*Continued from Page* 218)

Foreign Secretary should raise this matter with Generalissimo Stalin and Mr. Marshall in Moscow, where the time of the delegates will be fully occupied in discussing questions relating to the future of Germany.

Yours sincerely,
C. R. Attlee

SECOND STATEMENT STRESSES NEED FOR BIG THREE MEETING

We are grateful to the Prime Minister for his considered reply to our statement of March 7 on the International Control of Atomic Energy, and agree with the Prime Minister that, in the light of the subsequent discussions in the United Nations Atomic Energy Commission, our statement has been shown to be over optimistic.

We are glad that the Prime Minister confirmed that "our object should be to negotiate a comprehensive plan which besides banning atomic weapons, would establish an international authority, define its powers of inspection and control, and specify, in advance, a timetable for the transfer to the authority of those powers."

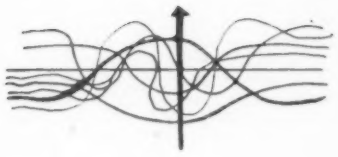
The need for control of atomic energy becomes ever more urgent. The longer the delay in reaching agreement, the less likelihood is there of retaining that minimum basis of mutual confidence necessary for the adoption and working of an effective control scheme. That minimum basis is rapidly disappearing. So long as weapons of mass destruction are developed in the armouries of the nations, we shall be living, in the words of the Foreign Secretary, in "a world crumbling to disaster." At least twelve countries now have government sponsored programs of research and development. These include the U.S.A., the U.S.S.R., Great Britain, Canada, France, Denmark, Norway, Sweden, Switzerland, Holland, Australia and New Zealand. Further, the mining of uranium and thorium is proceeding apace in at least seventeen countries. These include the U.S.A., the U.S.S.R., Canada, Argentina, Australia, Belgian Congo, Brazil, Bulgaria, Chile, China, Czechoslovakia, India, Mexico, Philippines, Poland, Portugal, and South Africa. Effective control must begin at the mines. The mining, distribution and processing of these vital ores by individual nation states will make it increasingly difficult to effect international control, if and when such control is agreed on.

We suggest that an immediate attempt should be made to break the deadlock, and for this purpose we hope that the Prime Minister will now show the same initiative as when he flew to Washington in November 1945 to meet President Truman and Mr. Mackenzie King, which led to the establishment of the Atomic Energy Commission. The work of the Commission is now approaching a standstill. The Russian representatives of it do not appear to possess the authority to enter into real negotiations or make decisions. We suggest that only by a meeting at the highest level can the new approach be made which is necessary for the solution of this problem within the time available.

We ask that the Prime Minister should take the initiative in suggesting an early meeting between President Truman, Marshall, Stalin and himself so that the present uncertainties can be authoritatively resolved.

We further ask that a time limit be set to the period within which the control of atomic energy can be permitted to remain a subject for inconclusive discussions.

MILITARY SUPPORT OF AMERICAN SCIENCE, A DANGER?



Louis N. Ridenour

Grateful acknowledgment is given to the AMERICAN SCHOLAR for permission to reprint in full here Professor Ridenour's article and the lively comments written by outstanding natural and social scientists which appeared in the Spring and Summer Issues of that periodical. *Dr. Ridenour is Dean of the Graduate School at the University of Illinois. During the war he was assistant director of the Radiation Laboratory of the Massachusetts Institute of Technology.*

The title of this article is pejorative, and suggests several conclusions which, under the present circumstances, are not altogether true. It suggests, first of all, that the Army and the Navy are interfering in a harmful way with the conduct of research in this country. It suggests that this "intrusion" is unwelcome to the scientists. Finally, it suggests that unless such "intrusion" is actively resisted by the scientists, it is bound to succeed; and that science will be harmed in consequence.

Each of these statements is partly true, which is to say that it is true today at some places, in some connections, and with reference to some institutions and individuals. But none of these statements is so generally true that it gives an adequate and fair picture of the present situation. To understand this remark, we must look carefully at the unprecedented circumstances which today govern the financial support of scientific research.

It is perfectly true that the major financial contribution to the support of scientific research has come during the past year, and presumably will come this year, from funds appropriated by Congress to the Army and Navy of the United States. The men charged with expending these funds to provide for the common defense have seen fit to apply a considerable fraction of them to the support of studies in science.

SCIENTIFIC RESEARCH HEAVILY FINANCED BY ARMED SERVICES

Exact figures are hard to come by, and are usually meaningless anyhow, since the definition of what is included in the term "scientific research" varies from one department of the Armed Services to another. Unofficial guesses have put the Army-sponsored research at $70,000,000 for 1946, and Navy research for the same period at $20,000,000. Both figures exclude research carried on in establishments operated directly by the Army or the Navy—such as the Naval Research Laboratory, or the great laboratories maintained by the Manhattan District. The present total is to be compared with the $30,000,000 available in 1940 for scientific research in all the universities of the country. The decline of the dollar notwithstanding, science has more money now than it had before the war; and the increase is wholly due to the backing that the Armed Services have seen fit to give.

ARMED SERVICES VIEW BASIC RESEARCH MORE FAVORABLY

Science is obtaining support from the Army and the Navy on so large a scale for several different reasons. First, many men in the Armed Services have an honest and enlightened belief in the importance of fundamental science to every activity of a technological civilization, including war. Many Navy and Army officers can give as good a pragmatic justification of free basic science as can any scientist. This justification derives, of course, from the familiar observation that engineering research, with its limited and foreseeable goals, by definition achieves only the obvious; while scientific research, having no goal but knowledge, every so often turns up a new discovery of overwhelming importance. Engineering research can give us a practical incandescent lamp, but the discovery of electromagnetic induction—on which the electrical age was founded—came from disinterested work in fundamental science. Engineering research will no doubt give us atomic engines for aircraft and ships; the discovery of nuclear fission, on which the atomic age will be based, was a product of fundamental research.

More than a hundred years ago, Michael Faraday is said to have replied to a member of parliament who asked him what *use* there was in his discovery of electromagnetic induction, "I don't know, but some day you'll be taxing it." Scientists have been making this sort of speech for a long time, to their fathers-in-law, to the heads of their universities, and to the prospective donors of research funds. It is something of a novelty to hear it from professional soldiers and sailors. But it is heard from such men today, and some of them believe it. A small but finite number of them really understand it, in the sense that they are able to distinguish between scientific research and engineering.

MILITARY ADMIRATION OF PRACTICAL RESULTS

A second reason for the support of science by the Armed Services lies in their admiration for the success of professional scientists in their wartime role of weapon designers. Secretary Patterson has said that ninety per cent of the equipment with which our troops were supplied at the end of the War was new, in the sense that it had either been designed *de novo* or had been thoroughly redesigned more recently than our entry into the War. Much of this design work, including some of the most significant, was done by scientists transplanted into engineering by the necessities of war. Both Services have made considerable effort to add academic scientists to the staffs of their own laboratories and development centers. Further, both Services are contracting with certain universities for work which, though it is called scientific research, is directly and foreseeably related to the design of weapons. Work on electronics and on guided missiles, together accounting for nearly a quarter of the research expenditures of the Armed Services, fall into this category.

Third, the Armed Services quite justifiably feel that they are fulfilling a public responsibility in supporting disinterested scientific research with federal funds during the absence of legislation providing for a civilian agency to dispense such aid. In the discussion of such legislation in the last Congress, it was clear that general agreement had been reached on its

desirability. Only the inability of its supporters to agree on administrative details prevented the actual passage of a bill. Under the circumstances, since the Army and the Navy can presently afford the expense, it seems appropriate that they should undertake the burden of federal support of research as a stopgap, pending the final creation of a civilian agency devoted to that purpose.

IS "BIG MONEY" NEEDED FOR SCIENTIFIC RESEARCH?

Does civilian scientific research need the large sums of money now reaching it through the Army and the Navy, and later to reach it through a National Science Foundation? The answer to this question is: for some things, yes; for others, no.

The last Nobel Prize in physics went to P. W. Bridgman of Harvard, a man who has for many years done superb research work on a modest budget, by himself, in the fine old nineteenth century tradition of individual, independent and productive science. He happens to be at the richest American university, but the work he does could be readily supported by any academic institution in the country that had the wit not to overload him with teaching duties. It is a matter of indifference to work like Bridgman's whether or not substantial federal funds are available for research.

However, in 1939 the Nobel Prize in physics went to E. O. Lawrence, of the University of California. Lawrence is the archetype of the big-time research worker. His Radiation Laboratory at Berkeley employs hundreds of people, has the biggest atom-smashing machines in the world (and still bigger ones projected), and operates on a budget running into one or two million dollars a month. Before the present easy availability of federal funds, Lawrence was doing a good job of supporting his laboratory on the basis of university appropriations and grants from foundations and private donors, but this would be far more difficult today. Not only have the costs of research gone sky-high—because of the general rise in prices and because of the increasing ambition of physicists' plans—but the availability of private funds has steadily declined. It is of the utmost importance to research establishments of the Berkeley type that there be large sums of money continuously available for their upkeep. Such sums have recently been supplied by the Army and the Navy.

It has often been remarked that, in terms of scientific yield per dollar, establishments like Berkeley are not nearly so productive as are the small groups headed by a scientist of Bridgman's type. Until Rutherford's death, he and his group did more and better nuclear physics with string and wax than most American laboratories did with their cyclotrons and electrostatic machines. While this is true, it overlooks the fact that certain types of scientific work cannot be done at all without great expenditures and a large establishment. On the basis of what we know today, the particle named the meson—which may have the greatest importance in the still elusive theory of nuclear forces—can either be studied as it occurs randomly and uncontrolled as a constituent of cosmic radiation, or in a laboratory that has a device capable of giving to electrons an energy in excess of 200 million electron volts. The research advantages of being able to produce mesons under controlled conditions are so obvious that several universities are currently building giant electron accelerators at the expense of the Navy or the Army. Such a machine costs a substantial fraction of a million dollars; it would have been almost out of the question for a single institution to build one, supposing designs had then been available, in the years before the war.

The conclusion here is that big science needs big money; and that, while big science is not the only part of science, nor even, perhaps, the most important part of science, it is sufficiently important to justify the availability of a certain amount of big money during the years to come.

HOW FAR ARE ARMED FORCES INTRUDING?*

Let us now ask to what extent the Army and the Navy are "intruding" in the laboratory in the sense of interfering with the choice of subjects for research, or of interfering with the conduct of research. First of all, it should be noticed that there is no compulsion to accept the funds proffered by the Armed Services for research use. There can be no intrusion on a laboratory that accepts no such funds. This suggests that "intrusion" is too strong a word, which is the reason that it has so often been written here in quotation marks.

However, there is one possibility for an undesirable interaction between the men who disburse the Army and Navy research funds and the character and subject of the work so financed. I have a friend who is a band spectroscopist on the faculty of a large state university. He has been particularly interested in the band spectrum of the element nitrogen. He once said to me: "When the representatives of the state legislature visit me, I always tell them I'm trying to make better fertilizer." There is, to be sure, nitrogen in fertilizer, and knowledge is power. It is just conceivable that my friend's investigations of the band spectrum of nitrogen may some day affect the fertilizer industry in some unexpected way. But it is undeniable that his interest is in spectroscopy, in and of itself.

In a similar fashion, there is a certain temptation, when writing a project proposal for submission to the Army or the Navy, to point out some way in which the work to be done is related to a military or a naval problem. Not long ago I saw a draft for a research proposal containing budgeted expenditures of tens of millions of dollars per year, for the prosecution of fundamental work in the field of atomic energy. The first paragraph pointed out that atomic bombs as we know them today convert less than a tenth of one per cent of the reacting atomic explosive into energy, so that a very considerable improvement is still possible. This is the same kind of connection of a research program with a possible practical result that links band spectra with fertilizer.

My friend the spectroscopist has established, by his scientific achievement, that he is not a fertilizer engineer. But if genuinely valuable scientific work is to be done in the atomic energy establishment just mentioned, it must be done by men who are not interested at all in the efficiency of atomic bombs, but are interested in finding out how nature works. It is possible that the mention of atom-bomb efficiency in research proposals will lead either to an expectation on the part of the Army that this is what it is paying for in backing scientific research, or to a belief on the part of scientists that, having mentioned this, they must try to deliver. Either outcome might be unfortunate, for it might increase the emphasis on federal support of engineering at the expense of basic science. Particularly with the wartime hiatus in scientific work to make up, this would be an unwise long-term policy.

In my wartime experience, it sometimes seemed to me that the Navy was a much more sophisticated organization than the Army. Certainly the Navy's professions of intent with respect to support of basic science are, from the point of view of the scientist, entirely impeccable. The Office of Research and Inventions, predecessor of the present Office of Naval Research, issued a little booklet about its aims and methods. A few quotations from this will illustrate the fundamental soundness of the Navy attitude. "It is recognized that research cannot be purchased under standard specifications such as are used for material goods." Again, "Freedom from security classification in fundamental scientific work is necessary to its quality and progress . . . It should be remembered that secret work is costly in time and money and is often of inferior quality." And again, "Research contracts are in the nature of partnership agreements, and offer the scientist freedom to initiate, explore, teach and publish in carrying out basic research for the Navy under the contract. It is believed that this procedure is one mutually beneficial to the civilian scientific fraternity and to the Navy, encouraging the scientist to conduct research in an atmosphere of scientific freedom and at the same time assuring the Navy that new

knowledge is being created from which developments may later come to improve the Navy as a fighting machine."

Under such arrangements, I can see no reason for refusing the Navy's help—granted it is forthcoming—in doing the scientific work that one would have tried to accomplish even without such help. A very few scientists and some laymen have lately taken the position that to do anything in which the Armed Forces are interested is *ipso facto* reprehensible, even though the work involved may be important in a non-military context.*

I cannot follow the reasoning back of such a belief, for it seems to me to yield many logical absurdities. Is it moral to pay federal taxes, when so large a fraction of the money so collected goes into maintaining the Armed Forces? And must one forego procreation? If a man begets children, and one of them is male, and there is a war, and this son is a soldier, sailor or airman, then he may kill others. It seems to me that the central point is this: when war becomes total, as it has done in our time, no useful thing can be accomplished without the risk—and even downright likelihood—that it will contribute to the effective prosecution of a war, if war there should be. The moral issue does not involve the technique or equipment with which a war is fought, but hinges on whether a war be fought at all. God told Moses not to kill; in no way did he indicate that one form of killing is less moral than another. This being so, those who hate war—and I am one of them—should concentrate on war, and forget about the tools.

IS MILITARY SUPPORT UNWELCOME TO SCIENTISTS?

Let us return from this digression to our proper subject. To what extent is Army and Navy support of scientific research unwelcome to the scientist? There seem to be three general attitudes among scientists on this point. The first is that just mentioned. In isolated instances, there are scientists who do not, on principle, wish to concern themselves with anything in which the Armed Forces profess to be interested. Not many institutions seem to take this view.

The largest category seems to include those institutions and individuals who, like me, have no objection to useful scientific work, even though it is for one reason or another interesting to the Armed Forces. Our concern is entirely whether this work can be done under such conditions that it will be useful for peaceful purposes: that is, done entirely without restrictions of secrecy. It cannot otherwise be viewed as an addition to man's knowledge, or even worthy of the name of science, since this comes from the verb **to know**. Secret work in peacetime seems particularly inappropriate when it is done in a university, whose major job is to disseminate knowledge.

Finally, there are a few institutions and a fair number of individuals who are quite willing to do their work under secrecy conditions almost as severe as those obtaining in time of war. This is sometimes regarded as immoral by men who confuse the rather minor matter of weapons design with the basic and tremendous immorality of war. There are others —cynics, perhaps—who applaud the fact that certain university laboratories are willing, for reasons of financial expediency or otherwise, to work behind a peacetime cloak of wartime secrecy on matters which can be investigated by any scientist anywhere. They say that the existence of such laboratories gives the rest of us an ever present reminder of how unwise it is to be seduced in this particular way. It is important to our final point to note that even here seduction is involved, not rape.

We must finally inquire whether the military "intrusion" into science will succeed to the extent of harming science, unless it is vigorously resisted by the scientists themselves. In my belief, this can hardly occur. For, if the military really dominates the management of a given scientific institution or the work of a given scientist, the urge for practical results will sooner or later turn the facilities of that establishment or the talents of that individual into engineering channels. Thus, although our national participation in science will have been reduced, science (which is international by definition) will have suffered little. In fact, since participation in such military engineering is optional to any institution or individual, only those scientists and research establishments having a predilection toward engineering work will take it up. Had they not been seduced by the military, they would almost surely have undertaken industrial engineering work sooner or later. This also would have removed them from participation in fundamental science.

Further, no active resistance is required of a scientist who wants to stay in science. He needs only avoid requesting any of the money that the Army and the Navy are currently so willing to provide him with. It seems quite needless, and even a little impolite, to inveigh against military support of technical work under such circumstances.

The danger with which the present situation threatens science, then, is not so very great. It is that, despite proper intentions like those stated by the Navy, service funds may be wrongly parceled out, from the standpoint of scientific yield. This will happen if they are awarded on the basis of foreseeable results, instead of on the basis of the probity, competence and judgment of the scientists involved. Precisely this same danger will exist when a civilian agency distributes federal research funds, so that the Armed Services do not themselves create the hazard.

To the scientist who is determined to keep his freedom and to work in science—to men like Bridgman—there is no danger at all. Such a man will conduct his research on a careful budget, foregoing all funds that carry strings. Necessity being the mother of invention, such poverty has frequently put emphasis on thought, and brought better research work in the end.

*See for example, Professor Wiener's letter on page 46 of the *Atlantic Monthly* for January 1947.

Replies to Ridenour

The Military Mentality

by Albert Einstein

It seems to me that the decisive point in the situation under discussion lies in the fact that the problem before us cannot be viewed as an isolated one. First of all, one may pose the following question: From now on institutions for learning and research will more and more have to be supported by grants from the state, since, for various reasons, private sources will not suffice. Is it at all reasonable that the distribution of the funds raised for these purposes from the taxpayer should be entrusted to the military? To this question every prudent person will certainly answer: "No!" For it is evident that the difficult task of the most beneficent distribution should be placed in the hands of people whose training and life's work give proof that they know something about science and scholarship.

If reasonable people nevertheless favor military agencies for the distribution of a major part of the available funds, the reason for this lies in the fact that they subordinate cultural concerns to their general political outlook. We must then focus our attention on these practical political viewpoints, their origins and their implications. In doing so we shall soon recognize that the problem here under discussion is but one of many, and can only be fully estimated and properly adjudged when placed in a broader framework.

The tendencies we have mentioned are something new for America. They arose when, under the influence of the two World Wars and the consequent concentration of all forces on a military goal, a predominantly military

mentality developed, which with the almost sudden victory became even more accentuated. The characteristic feature of this mentality is that people place the importance of what Bertrand Russell so tellingly terms "naked power" far above all other factors which affect the relations between peoples. The Germans, misled by Bismarck's successes in particular, underwent just such a transformation of their mentality—in consequence of which they were entirely ruined in less than a hundred years.

I must frankly confess that the foreign policy of the United States since the termination of hostilities has reminded me, sometimes irresistibly, of the attitude of Germany under Kaiser Wilhelm II, and I know that, independent of me, this analogy has most painfully occurred to others as well. It is characteristic of the military mentality that non-human factors (atom bombs, strategic bases, weapons of all sorts, the possession of raw materials, etc.) are held essential, while the human being, his desires and thoughts—in short, the psychological factors—are considered as unimportant and secondary. Herein lies a certain resemblance to Marxism, at least insofar as its theoretical side alone is kept in view. The individual is degraded to a mere instrument; he becomes "human materiel." The normal ends of human aspiration vanish with such a viewpoint. Instead, the military mentality raises "naked power" as a goal in itself—one of the strangest illusions to which men can succumb.

MILITARY MENTALITY MORE DANGEROUS NOW

In our time the military mentality is still more dangerous than formerly because the offensive weapons have become much more powerful than the defensive ones. Therefore it leads, by necessity, to preventive war. The general insecurity that goes hand in hand with this results in the sacrifice of the citizen's civil rights to the supposed welfare of the state. Political witch-hunting, controls of all sorts (e.g., control of teaching and research, of the press, and so forth) appear inevitable, and for this reason do not encounter that popular resistance, which, were it not for the military mentality, would provide a protection. A reappraisal of all values gradually takes place insofar as everything that does not clearly serve the utopian ends is regarded and treated as inferior.

I see no other way out of prevailing conditions than a farseeing, honest and courageous policy with the aim of establishing security on supranational foundations. Let us hope that men will be found, sufficient in number and moral force, to guide the nation on this path so long as a leading role is imposed on her by external circumstances. Then problems such as have been discussed here will cease to exist.

Science Should Be Kept Free

by Philip Morrison

Assistant Professor of Physics at Cornell University, Prof. Morrison was a physicist with the Chicago and Los Alamos laboratories of the Manhattan Project.

Professor Ridenour has an enviable reputation for supple and ingenious writing. The piece before us here continues in that vein; it is as clear as it is wrong. There is in fact a large-scale and potentially disastrous intrusion of the military into American science; unless it is resisted by scientists and by the public as well (already the Secretaries of both War and Navy have publicly disclaimed any intention to continue the policy) it might well bring great harm not only to science but to all our hopes for peace.

It is not my intention here to attack the soundness of most of the sprightly contentions of Professor Ridenour's essay; they are mainly true. They are also nearly entirely beside the point. He has not discussed the problems before scientists today, but their shadows. His pictures are so sharp: of the reasonable men of the Office of Research and Invention entering into contracts with informed and wary university scientists, of the sturdily individualist follower of Bridgman remaining aloof from entangling grants, of the men enticed away from science to engineering being counted as no loss "because they would almost surely have undertaken industrial engineering work sooner or later." This is not the flesh-and-blood world of 1947, but a dreamy and lifeless model sounding like nothing so much as the Manchester economics of enlightened dealers in a free market. Is the problem so simple a one? Let me report on an experience of my own in the college town of Ithaca, N.Y.

The local newspaper carries a weekly page of photographs on some topic of the day. Some time ago we physicists were pleasantly surprised by the sight of a set of pictures about cosmic rays, the most dramatic branch of modern physics. A group of research workers at the University of Virginia were shown with their curious Geiger-counter telescopes climbing through the dark limestone caverns of their state to measure the penetration of these rays deep into the earth. This is a normal and not very expensive branch of cosmic ray research.

Now it happens that this group of workers is supported by Navy funds. The pictures and captions were evidently released by the tireless Navy public relations office. The captions were incredible. This was their burden: The rays were shown to be millions of times more powerful than those of the atomic bomb. The weapon of the future well could be the cosmic ray. Could we but bore a hole in the air to let them in on our hapless enemy, his rivers would boil to steam, his land scorch, and his body be ash in a second! Thus does American physics, supported by our Navy, advance the cause of science. I need not add that the penny-dreadful style compounded its crass inhumanity by being scientifically absurb. Sunburn would be many times deadlier than cosmic rays if the atmospheric blanket were magically removed. But too many people understand sunburn; its publicity value is low. Now, it is clear that the sophisticated officers of the ORI no less than Professor Beams understand that cosmic ray work is but fundamental science. But does the misinformed taxpayer in Ithaca? More, does the still less informed European who hears that our country spends a billion on military research, on the heels of the first use of the atomic bomb? The scientist and the Services are not the only parties to their contract: the terms are desperately important to every man everywhere, and he cannot read the fine print.

Plans are now under way to give generous military scholarships for students as well as publicity and research funds for science. What sort of competition will this provide for the men who choose to remain in free science? Not everyone, either, is a Nobel Laureate, or head of a laboratory. Many men and women are the rank-and-file workers in science from whose myriad bits of patiently carved mosaic the occasional great scientist assembles the picture of truth. How will such people stay out of the military ties, when their department heads are convinced of the needs for grants? And will the grants now made so intelligently and freely remain so when military budgets dwindle and results are wanted? Or will the commitments now undertaken when the strings are missing bind all but the most resolute at a time when restrictive conditions reappear?

Science is not apart from society. Its purpose, its results, and its people are part of the fabric of human life. We in America want and need peace. We cannot tie science to the military and hope to see it used for peace, no matter how ingeniously we write the contracts, nor how circumspect the men of good will remain. Moreover, science is in need of social aid. It must obtain that aid in the name and right of research, not masquerading as an arm of war. A strong science requires national acceptance and understanding. And in the world of peace we all so much long for, science must be again the pursuit of truth for all men, not for Americans alone. It cannot be so if it is narrow, national, secret; it cannot be so if it is regarded everywhere as but the zealous armorer of a new and more dreadful war.

The Congress is now about to consider legislation establishing a National Science Foundation, a federal agency which will grant scholarships and research funds in the name of science, not that of war. It is the duty of every reader of *The American Scholar* to acquaint himself with these measures and, if he is convinced of their soundness, to lend them his practical support.

A Positive Program of Research for Peace

by Aldous Huxley

The military are "intruding" into science, because they hope that an increase in knowledge will lead to the development of more effective weapons. Scientists are advised by Dr. Ridenour to "resist intrusion" to the extent that it threatens to degrade pure science into mere engineering. By Professor Wiener, they are advised to resist it absolutely and unequivocally, on moral grounds.

This negative procedure of "resistance to intrusion" requires, it seems to me, to be supplemented by some form of positive action, designed to offset the military program of research for war, and to render it unnecessary.

The present predicament of the human species can be summed up in a few sentences. (1) The two and two-tenths billion inhabitants of the planet do not have enough to eat, and by the end of the present century their numbers will have increased to three and three-tenths billions. (2) Over the greater part of the earth, soil erosion is rampant. (3) Western industrial civilization is based upon the exploitation of wasting assets. What we call "prosperity" is the consequence of rapidly dissipating our planetary capital. (4) When they are found in an industrialized country, hunger and a shortage of raw materials lead to aggression. Where the industrial means to aggression are lacking, they lead to unrest, anarchy and to that end-product of anarchy, tyranny. (5) Democracy cannot flourish in a country where population presses heavily upon resources. The twentieth century is an age of dictatorship, because it is an age of planetary overcrowding. There is not, as in the past, a Virgin New World to relieve the mounting pressure. (6) Asia, Africa, Eastern Europe and South America have very high birth rates. Western Europe, Australasia and North America have low birth rates. In the context of modern nationalism, these differences constitute a standing invitation to aggression and preventive war.

Political foresight and a rational planning of human destinies are possible only in a world where population is stable, and where birth rates and death rates are uniformly low. Hence the need for an international population policy. But such a policy, even if adopted tomorrow, would not take effect (owing to the large numbers in the reproductive age groups) for at least two generations. In the interval we can merely palliate the political and economic symptoms of the underlying demographical crisis. Workers in pure and applied science should combine, it seems to me, to plan a program of research aimed at removing some at least of the present causes of war and tyranny.

(1) Basic research in chemistry and biology might result, among other things, in the discovery of methods for producing foodstuffs artificially. e.g., through the synthesis of chlorophyll. (2) Less basic research might show how many agricultural wastes could be converted into nutrient solutions for edible yeasts. (3) A long-range study should be undertaken of the means whereby our industrial civilization could be shifted to a foundation less precarious than the exploitation of rapidly dwindling mineral deposits. The aim should be to find surrogates which can be produced from raw materials that are practically inexhaustible. A similar research should be undertaken into universally available sources of power, such as the wind and the sun. Power sources such as petroleum, coal and uranium are natural monopolies, whose possession by a strong country is a temptation to aggression, by a weak country an invitation to exploitation by the strong.

If drawn up by an international body of scientific workers and presented to the various electorates of the world, a program of this kind should be certain of popular (though not necessarily of governmental or military) support. For on one thing at least, all human beings are agreed: they want to have enough to eat. Men can get on very well without atomic energy; but they cannot dispense with bread.

The Seven Propositions of Professor Ridenour

by Robert K. Merton

Dr. Merton is Associate Professor of Sociology at Columbia University.

With great lucidity, Professor Ridenour summarizes present-day relations between scientists and the military in seven propositions: (1) the disinterested makers of policy in the Armed Services are deeply concerned with advancing free basic science; (2) the self-denying military see themselves as a useful stopgap pending the establishment of a federal civilian agency in support of research; (3) the large resources of the prosperous military are admirably suited to provide the big money needed for certain types of research; (4) the unintrusive military interfere with neither the choice of subjects for research nor the conduct of research; (5) scientists, young or old, well-endowed or not, have the unqualified option of refusing to be seduced into a life of secrecy by the munificent military—and, further, they enjoy complete safety from rape by the men in uniform; (6) the diversion of interest from basic to engineering research occurs only among those scientists predestinated to make that choice; and (7) research subsidized by the communicative military in time of peace need not entail secrecy.

Thus Professor Ridenour announces a momentous and largely unnoticed reversal of roles in the relations between scientists and the military. His image of a disinterested, self-denying, unintrusive, prosperous, munificent and communicative military placing themselves at the service of free basic science cannot but give heart to those scientists who have suffered from illusory contrast-images. To them, the quiet surrender of the Army and Navy to the men of science will be as welcome as it is unexpected.

In Professor Ridenour's world, men of war are strangely willing to yield their own professional interests to the internationalism of free science, which knows no national boundaries. In this world, the military eagerly expends substantial funds only to make the more certain a civilian agency which will, one must suppose, supplant their own war-oriented concerns with more peaceable types of research. Some scientists have evidently not caught up with this turn of affairs. Misunderstanding the disinterested purposes of the Armed Forces, they make the unpardonable error of seeking to have "the work to be done . . . related to a military or naval problem."

Indeed, scientists are not infrequently at fault. For despite the concern of the military with basic research, some scientists insist on rising to the lure of large research funds made available by the Services and turn away from science to "engineering work." But, as Professor Ridenour points out, these men have only themselves to blame. For, like the members of a more ancient profession, their behavior testifies that eventually they would have given way to temptation.

However, young scientists who wish only to set about their business of basic research have little to fear from refusing the largess of the Armed Services. Whether they seek fellowships or research appointments, they may, if they wish, confidently turn away from research supported by the military without incurring more than a nod of approval by their heavily subsidized superiors in the academic bureaucracy.

But perhaps the finest moment of creative imagination in Professor Ridenour's essay is to be found in his allusion to scientific research supported by the Armed Forces and "done without restrictions of secrecy."

Soldiers and sailors who read Professor Ridenour's account may uneasily suggest a more appropriate title: "Should the Military Resist the Intrusion of Scientists?"

Social scientists who read the account may ask: Can this be really so? And, in seeking an answer, some may request the Armed Services to support an objective empirical inquiry among a representative sample of the nation's scientists who have worked with the support of the military in order to determine how much of Professor Ridenour's world is fancy and how much, fact.

An Economist Views the Problem

by Seymour E. Harris

Seymour E. Harris is Professor of Economics at Harvard University, Managing Editor of the *REVIEW OF ECONOMIC STATISTICS*, and author of numerous books on economics.

Professor Ridenour has written an eminently sensible paper. His theme seems to be that the military in making large funds available will help rather than hamper science; that scientific projects requiring gargantuan equipment (e.g., cyclotrons, giant electron accelerators) are no less important than those requiring the attention of great scientists working with modest resources (e.g., Rutherford, Bridgman); that those scientists who, by military grants, will be lured from pure science to participation in engineering projects, would probably have been tempted by industry in any case; that the squeamish reluctance incidentally to aid the military is not a rational basis for refusing to work on government-sponsored scientific projects.

Since Dr. Ridenour's position is reasonable and well balanced, the social scientist's contribution to the discussion of the military or government's relation to science is supplementary to, rather than critical of, his position.

Apparently the military contributed $90,000,000 in 1946 for scientific research—a figure to be compared with $30,000,000 available for all scientific research in all universities in 1940. Total expenditures for research of all kinds in 1940 were roughly estimated at $345,000,000 in the report to the President, *Science, the Endless Frontier:* industry $234,000,000; government, $69,000,000; colleges and universities, $31,000,000; research institutions $11,000,000.

TOTAL RESEARCH EXPENDITURE SMALL

Both military and total research expenditures are scandalously small. Here is a country that turns out 170 *billion* dollars' worth of goods in a year. An atomic war, or any kind of an ultra-modern war, is almost certain to be crippling and destructive—far beyond the millions killed or harmed physically or mentally, and far beyond the 350 billion cost of World War II to this country. Whether we will have to go through the agony of another war and whether we would win such a war will largely depend upon this race of scientists. The writer, anxious for peace with the U.S.S.R. and confident of our success in resolving our difficulties, would not classify himself as a red-baiter. I am, however, aware of a regrettable philosophy which has percolated to the masses and which serves to make one cautious. That philosophy suggests the inevitability of a dog fight with capitalistic nations; but the "inevitable" fight will not come off so long as it is clear to all that the U.S.S.R. is likely to lose. Until war is outlawed then, we must spend generously on science.

Professor Ridenour is then indeed right to poke fun at those who would not even incidentally help the military (cf. Mr. Wallace in the *New Republic*, February 3, 1947). Once the world has really outlawed war, then indeed the scientists may turn their backs on the military. With modern advances in warfare, the dollar spent on science becomes a much more valuable dollar than the dollar spent on ammunition or soldiers. How long will it take before the military realizes the new pattern of expenditures required by modern warfare? The optimum expenditures on science might well run into the tens of billions of dollars.

GOVERNMENT AID TO RESEARCH INCREASING

In spending billions for research, we might stave off war or, in case of war, save millions of lives, assure the salvation of at least part of our 500 billion-dollar plant and retain most, if not all, of the 150-250 billion dollars of annual income over the next twenty-five years. That we shall not spend so much is almost certain—and not merely because the issues are not adequately understood by the military and Congress. It will take years to train the required scientists, build the necessary laboratories, and convince the country that the concomitant budgetary deficits and deterioration of current living standards would be worth while. (Beyond a certain point, needless to say, training potential carpenters to become nuclear physicists or chemists will yield diminishing returns.) But even more important is the fact that the expenditures in dollars, in man power, in the way of life involved, in creating the required scientific machinery would be so great, that far short of the optimum level, we would simply call a halt. There are some terms under which we prefer not to live, or at least to forego security.

Government aid on a large scale for research in the pure sciences is on the way. Even a penny-pinching Congress, which will sacrifice security to save dollars, and trade unwise remission of taxes for votes, will not be able to stop the inevitable. It is certain that government will and must play a larger part—first because the privately endowed institutions and the private foundations, the main source of research funds for pure science in the past, are waging a losing fight. Inflationary pressures, declining rates of interest, increased taxes and the general weakening of the fabric of capitalism all militate against these private sponsors from maintaining their relative position. Universities may still earn 4 per cent on their investments; but the risk element is large and, therefore, part of the return is spurious—as the first big depression will reveal.

There is a second and perhaps more important reason for increased government participation; and this applies not only to research for military purposes, but even more for peace purposes. For many years the government has been spending funds on research—to improve the manner of spraying trees, to obtain better seeds, to discover the distribution of liquid assets, *et hoc genus omme*. The occasion is generally that private enterprise could not afford to spend this money, since the gains, inadequately protected by patents, accrue quite generally; or that the expenditures involved are so large that private enterprise could not mobilize the required resources or dare not risk expenditures on the required scale. The release of atomic energy dramatizes the research project too large for any business enterprise or conglomeration of enterprises to handle. It is a reminder that where the nation's gains are a multiple of the government's cost, and where there is no alternative to government sponsorship, a virgin field has been opened for government research. This is just another example of government spending for the public welfare, where the gains in national income or (and) human welfare may well greatly exceed the cost to the Treasury, and where in effect the Treasury's gains in revenue may well exceed the outlay.

WILL TALENT BE DRAINED FROM "PURE SCIENCE"?

Our final point relates to the draining of talent away from pure science. Here I fear that Dr. Ridenour is rather optimistic. In the present state of income distribution, in particular where a professor with $10,000 income receives after taxes the equivalent in goods of what $5,500 would have yielded in 1939, or one with a $6,000 income, the equivalent of less than $4,000, the temptation to desert pure science for a minimum standard of living is indeed irresistible for many. It is not enough to say they would have been tempted in any case. With more and bigger prizes offered under government aegis, "scientific prostitution" will grow. In the social sciences, where government or industry will pay young men two or three times what universities can afford, the migration has been serious. A large proportion of able young men in economics, for example, are now in government; and the drain to business of economists who have the "correct" views is not to be minimized. At a price, many able theorists become economic practitioners or defenders of private enterprise. (A large proportion would in any case have sought government or business careers and would have found the

work and viewpoints congenial, but not all.) These losses are undoubtedly reduced, if not entirely recouped, by the response of talented young scientists, natural or social, to the increased funds made available. And the economic practitioner, or the engineer, also adds something to science.

A final suggestion. Would it not be an effective use of research dollars, from the viewpoints of both government (inclusive of the military) and science, if subsidies were paid to the best of the pure scientists, for the dual purpose of enabling them to continue their work and giving them the minimum amount of help for research assistance and laboratories. (I assume that the scarce resources are first-class pure scientists; and they above all should be saved for the most general and most important work.) In this manner, the contribution per Einstein, per Bridgman, etc., will be a maximum, and excessive diversions from pure science stopped. The great tragedy results when the potential Rutherford, Einstein, Curie, Rabi or Bridgman yields to economic pressures. Perhaps the National Science Foundation will discourage the wastage involved in transferring great talents from pure science to engineering.

Facts and Values

by William Y. Elliott

Dr. Elliott is Professor of Government at Harvard University.

The clear and persuasive paper of Professor Ridenour has evoked on the whole favorable comments from Dr. Bush, Dr. Young, and my colleague, Professor Seymour Harris. These may be summarized by saying that Dr. Bush is convinced that, in the light of his own broad experience, science has little to fear from crippling of its freedom by military restrictions attached to grants for "pure research." Dr. Young wants to extend the range of research, and views the government as the natural source for its support, even in the social sciences. Professor Harris feels that our outlay for research has been scandalously small and takes the realistic view that, as long as we are in what is, certainly so far, a power struggle with Russia, our best protection is to keep ahead.

On the other hand, Professor Morrison fears the enveloping atmosphere of military control, the misinformation of the taxpayer that is involved by vulgarizing the contributions of science to our defense, and the danger that foreign nations (not specified) will be frightened by a billion spent on military research. He is at least as much concerned about the "creaming" of potential students by the Navy, and probably soon to be paralleled by the Army.

Professor Wiener's objections are twofold. He objects to the indiscriminate clapping of restrictions on free research; and he distrusts military control. This distrust is illustrated by his classic sentence: "If our little boy is beset by bullies, we may teach him how to box, but we do not give him a razor to carry." He does not believe that the military are to be trusted, since they have used the atomic bomb.

Any analysis of this basic issue depends upon two sets of problems: one is in terms of fact, and the other is in terms of value.

I submit that the facts are about as follows, and that this statement might command—at least up to its final statement of Russian behavior—general assent even from physical scientists, who are much more conversant with the facts of laboratories and experimental control of matter than with the forces of politics.

Few doubt that we are at the present time confronted with a problem in the control of atomic energy that is somewhat different from the relation of a small boy to bullies. It involves the possibility of the destruction of a considerable part of civilization, if a solution is not reached; or, alternatively, the possibility of a prolonged period of armed suspense between systems which have not been able to agree upon a common and secure method of preventing the use of atomic energy for purposes of destruction.

So long as the latter situation exists—and it must exist until a common formula of control has been accepted and, beyond question, put into workable operation—not only the scientist, but the whole industrial structure of the United States and probably of other world powers, will be increasingly geared into a military system capable of acting on a moment's notice. It is not "pure" science alone that is endangered. The whole range of industrial and technical know-how in the world becomes a military factor. The presence of potential Fifth Columnists is a matter of uniquely perilous concern. Unless we assume the pacifist philosophy that the best defense is no defense, the growth of military controls and an increasingly totalitarian temper would seem to the political scientist inevitable. The pacifist attitude is not likely to triumph, for reasons that are beyond the scope of this short summary. But I think they are not likely to be disputed.

Now for the more doubtful factors: on the evidence so far the Russian system is quite unwilling, except for purposes of tactical delay and propaganda, to discuss with an open mind, and much less really to institute, any international control that would effectively insure tht security of other systems against the possibilities of the misuse of atomic energy for military purposes by the Soviet system, or that would prevent the unlimited development of atomic energy within that system. We cannot, of course, close the books on this without further efforts to persuade the Politburo to change the attitude that has been publicly and repeatedly expressed by Mr. Gromyko as their official policy. In the meantime, we must accept the facts as they appear to be.

Now for the question of value: if the facts are as stated, we have as one alternative, the maintenance of an "open system," based upon the unsubsidized (by government) operations of independent researchers in science, not geared into defense programs. This is obviously a more attractive world in which to live, both for scientists and for citizens who are persuaded of the values of liberalism in the enduring sense of that term. If academic and scientific "freedom" are the highest values, and life is not worth living without them—and if they are "absolute" values—perhaps this is the right line. On the other hand, so to act is to take certain grave risks about the survival of our whole system. We should definitely have to accept the inability of that system to prevent incursions on the freedoms of other systems as well as our own, or to protect the prospects of a world order, based upon the freedom of nations and their common acceptance of law by consent.

The other alternative is to say that our system is worth putting as far as possible beyond the reach of intimidation and in the position of supporting a workable system of protection of international law and justice. We *may* lose our freedoms in a struggle to maintain this kind of a world—a struggle which is not of our own choosing. We certainly lose freedom for the world if we let it go by default.

To rely upon (a) scrapping our A-bombs, (b) professions of outlawry by treaty of atomic energy for war purposes, and (c) the good faith of a totalitarian system—all of which we are urged to do by the Party-line followers—would appear in terms of value to gamble with our national survival, certainly with our future as a world power and the protector of the system of human rights.

When Professor Wiener and his fellows among the scientists are prepared to demonstrate for us a world order that differs from the facts of a conflict of two great world systems, in their struggle for what may be the future of science as well as the human soul, then we may be able to bring science back into its free role. Until that time, we cannot entrust ourselves to a prescription by or for "small boys." We shall have to assume the responsibilities of maturity in a most unpleasant world until we are able to change it and establish the conditions of moral order that can bring under control the Four Horsemen of the Apocalypse, who are still riding.

Dangers to Research, If Recognized, Can Be Avoided

by Vannevar Bush

Dr. Bush, President of the Carnegie Institute of Washington, has been Director of the Office of Scientific Research and Development since 1941, and is chairman of the Joint Research and Development Board.

The long tradition of freedom of knowledge is a characteristic of science to which Dr. Ridenour properly gives much emphasis in his analysis of the attitudes which he holds scientists may take toward government support of research. Inevitably, such emphasis tends to bring into disproportionate prominence the fact that some programs connected with the national defense must for the common good be conducted in secrecy, and to throw into correspondingly disproportionate obscurity the fact that—even under the temporary system whereby Federal money is channeled through the Armed Services—a very substantial part of the basic research thus financed is as free of restrictions as ever research has been. I quite agree with the general treatment of this important matter which Dr. Ridenour ably presents. The great point is not that there are dangers that research in this country may be placed on a false or unwise basis (there have always been such dangers); the great point is that if we fully recognize them we can surely avoid them.

As for the possibility that continuing use of public funds to support research might weight the balance too heavily on the applied research side, I believe that the availability of federal funds does not raise any new problem, although it certainly brings into relief an old one. If our scientific undertaking as a whole is to be of the maximum social value, effort must be properly distributed in the basic research which discovers new knowledge, and in the applied research which makes knowledge effective in controlling the environment and bettering the conditions of life. Scanting of either form through overemphasis on the other is obviously short-sighted. The interest of the scientist and the interest of the public are parallel here. During the wartime emergency, great emphasis on applied research was natural and proper. It should be noted, however, that that emphasis was a result of the war needs, not of the federal financing; it does not at all follow that federal financing in times of peace means a continuation of extra demands for applied research.

The greater significance of both the present interim function which the Services are ably performing, and the hard thinking which is being done on the formulation of legislation for a National Research Foundation, lies in two facts too often overlooked. These facts are that we are now in the process of recognizing, defining and establishing a clear relationship between government and science, as one of the major components of our civilization; and that this time we are carrying that process through with more consciousness of what we are about than we had, say, in developing a similar relationship between government and such other components of society as agriculture or the transportation industry. The phenomenon should be of profound interest to social scientists, for it seems to indicate not only that research—which we may here consider to be the deliberate application of intelligence to the increase of knowledge and to the control of the environment—is now recognized as a major concern of the people as a whole, but also that we as a nation have attained maturity in this regard.

The Armed Services Are Not Fit Almoners for Research

by Norbert Wiener

Norbert Wiener is Professor of Mathematics at the Massachusetts Institute of Technology. In a letter published in the January number of the *BULLETIN*, he refused to give technical information concerning controlled missiles to a scientist working for a great aircraft corporation.

An article such as Professor Ridenour's may be written from several points of view. From one point of view, the word "should" applies to the scientist in his full duty as a scientist, a citizen and a responsible human being. From another point of view, the duties of a scientist are considered from the narrow point of view of what is called "professional ethics," in the sense of the code of conduct adopted by a profession for the minimization of internal friction, and the aggrandizement of its vested interests as far as they determine its attitude to the rest of the world, together with a certain modicum of pious respectability. This second standpoint is that of Mr. Petrillo, Dr. Fishbein, and, I gather, of Dr. Ridenour.

Dr. Ridenour, as an administrator of science, finds that "there is no compulsion to accept the funds proffered by the Armed Services for research use." As an older working scientist, I too have found no such compulsion, for I am in the position to refuse them and to choose my own problem. I wish I were able to say the same thing of my younger working colleagues. Their refusal to take a job handed to them by the Navy through their administrative superiors is much too frequently a refusal to eat.

Dr. Ridenour puts the public benefits of the improvement of the atomic bomb as a parallel undertaking to the study of nitrogen treated as an attempt to make better fertilizer. This public spirit may have a meaning after we have decided to push the civil uses of atomic energy ahead of the military uses. At present, our authorities have made exactly the opposite decision, and this excuse is sheer humbug.

The Navy may have the praiseworthy sentiments opposed to secret research which are attributed to it by Dr. Ridenour. I do not care to test them. If a piece of work done by me under Navy contract should prove to be directly applicable to the design of a new weapon, I should have to communicate it to some Navy authority, and in the natural course of events, I should expect a classification to be slapped down on it before I could say "Vannevar Bush." This is exactly the experience I had in 1940, before we entered the war, at the hands of a civilian organization engaged in war research.

The Armed Services are not fit almoners for education and science. They are run by men whose chief purpose in life is war, and to whom the absence of war, even though a war is almost certain to engulf them personally, is a frustration and a denial of the purpose of their existence. They are run by men who have been drilled into a highly specialized scheme of subordination and superordination. What makes a man a good soldier, generally makes him a bad scientist, and a totally unsuitable administrator of science.

The compartmentation of science which, for all Dr. Ridenour suggests, dominates most of Army-and-Navy-subsidized research, is fatal to the moral responsibility of the individual scientist. The one time at which he can effectively assert his moral judgment is, therefore, when he enters upon a program of service research.

Finally, to say, as Dr. Ridenour does, that "the moral issue does not involve the technique or equipment with which a war is fought," is completely specious. The purpose of war is only superficially to defeat the enemy. It is fundamentally to avoid a threat, or secure a prosperity, or express an indignation, or what you will. Under modern conditions, it leads to a loss to both sides, and it is only the excess of gain over loss, whether physically or morally, which marks its success, just as it is the excess of therapeutic action over toxicity that marks the value of a drug. A weapon which brings upon us the demoralization of the responsibility for needless and indiscriminate slaughter; a weapon which blackens our name in the eyes of the world; a weapon which gives the control of the entire destinies of our countries into the hands of a few people who know no control; a weapon which has no riposte other than the counter-slaughter of our civilian population; such a weapon is a bad weapon—technically, strategically and morally.

If our little boy is beset by bullies, we may teach him how to box, but we do not give him a razor to carry. This is partly because the razor is just as dangerous to him as to his assailants, and partly because there is such a thing as too great a violence in reply to an attack, as the criminal law knows very well. To give the atomic bomb to those who profess to be able to come to a decision as to whether to use it in no more than two weeks after its first trial, does not differ in its wisdom from putting a razor in the hands of a five-year-old child!

Subsidies Acceptable with Proper Safeguards

by Donald Young

Donald Young is Executive Director of the Social Science Research Council. He is on leave from the University of Pennsylvania, where he is a Professor of Sociology.

The present commentator can do little more than agree wholeheartedly with Dr. Ridenour's dispassionate disposition of the bogey of military domination hovering over science in America. It may be in place, however, to suggest that Dr. Ridenour's limitation of his argument to the natural sciences is a function of his personal area of specialization. Each of his well-made points with regard to the natural sciences applies also to the social sciences.

Research in the social sciences, whether it be labeled economics, sociology, social psychology, political science or anthropology, is simply the objective analysis of some selected aspect of human relations. It is based on the assumption that human behavior is no more essentially capricious than that of the atom, and that it is consequently possible to gain more knowledge concerning social phenomena through the use of suitable objective techniques than through more casual and intuitive approaches. The military services obviously need such knowledge, both for the operation of their own enterprises and in planning their strategy and tactics. National security, as well as national welfare, requires sound knowledge of factors affecting human relations. That this is the case is well established by the large-scale utilization of social scientists by war agencies during and since World War II, and by current military support of social science research projects.

There is, however, even greater fear that social science research may be dangerously warped by military support than that natural science research may be misdirected or perverted. That there is real justification for this greater apprehension is obvious when one considers, first, that it is more difficult to be objective about the behavior of one's fellow men than about inert matter or even living tissue; second, that the behavior of people is perhaps the most complex of subjects for study; and, third, that the social sciences are the least mature of all the disciplines and still suffer from the handicaps of underdeveloped techniques and inadequate personnel. The antidote to this fear, of course, is not to avoid the issue but to spur the efforts of social scientists to meet the extra difficulties in their situation. One of the greatest obstacles to the sensible program of working harder in the social sciences because the tasks are more arduous, is that so many people retain confidence in the validity of their own notions about the resolution of problems of human relations, even in the face of contrary evidence. It is much easier for every man to regard himself as an expert in the social fields than in such fields as chemistry and physics, whose basic problems seem less familiar. Under the circumstances, it is natural to assume that military support of social science must mean a serious degree of military dominance of procedures and results.

A quick review of the more traditional sources of support for research in the social sciences may serve to weaken the belief in the inevitability of harmful military dominance of research financed by the Army and the Navy. Most research in the social fields in the past has been subsidized in an indirect manner, for it has been in good part a leisure time activity, something in the nature of a luxury, carried on by professors in the hours not given to teaching and other university duties. Another form of subsidy by academic institutions has been the provision of material facilities, such as books, housing and computing machines, of whole or partial relief from teaching and administration, and of direct cash grants from the institutional budget. In an appreciable number of cases private individuals have given of their funds for specific research projects. Philanthropic foundations, of course, have long been a main reliance for the support of both large and small research enterprises. Another major source of support for research in the social sciences, which is commonly minimized if not overlooked, is government, both state and national. Although no conclusive data are available, it is probably accurate to say that down to World War II a larger proportion of social than of natural science research has had government support. Social scientists also have been accepting support directly from business and industry without serious criticism from their fellows because of the source of their finances. There seems to be no good reason to believe that academic boards of trustees, heavily weighted with non-scientific citizens; private individuals wealthy enough to subsidize research; business executives and men who control the expenditures of non-military governmental agencies are either more or less inclined than the military to "intrude" in the research which they support.

There is no source of funds for research in the social sciences from one point of view or another cannot with some justice be called "tainted," if by that we mean that the laymen in control of finances have some personal concern about the nature of the findings in projects which they support. Such bias is not unknown in the natural science fields. But protection against bias of this kind is entirely possible. Money can be sterilized for research purposes in passing from one hand to another, if both parties to the transaction are truly interested in research. It is up to the research man to make certain that this is the case, or else refuse to be a party to the deal. That some men will yield to temptation and accept funds under conditions fatal for the maintenance of decent research standards may be taken for granted, but this is a matter of individual integrity and not dependent on any inherent difference between military and civilian auspices.

A Primary Influence Ignored

by Douglas P. Adams

Douglas P. Adams is Assistant Professor of Graphical Mathematics at Massachusetts Institute of Technology.

A rival picture-poetry to Dr. Ridenour's lissome phrases need not be attempted in a three-hundred-word ambit. Apart from this particular charm, the Spring Forum was bereft of force and interest because of its lack of orientation with respect to a primary influence. The omission raises a second, more fascinating question.

I assume no competent, sincere evaluation of Kremlin ambitions fails to list them among the primary influences of earth's current politics. I am not referring to convictions one way or the other as to whether these influences should be accepted or parried by any state, but simply to their existence and importance. In the Spring Forum, four of the five scientists did not mention the Kremlin or allude to it affirmatively. Dr. Bush's remarks alone imply the cogency of its influence. The sixth reporter, notably an economist, paid the Kremlin sufficient service to dispel the thought that Forum policy might have deemed it best unmentioned at the moment. Unoriented with respect to this primary influence, the Forum immediately lost momentum and clarity.

Until recently, no matter how badly men treated each other, Nature exceeded man as man's worst enemy. In an economy of abundance, it is clear that Nature will have yielded to man as the chief threat to a generous human survival. The world looks again in desperation to the scientific mind and method for leadership, as contrasted, let us say, to that of inveterate politics. Will the same type of mind and thinking prove as competent against the ills of man's mind as against those of his body? —against those of his heart as against the tribulations meted out by Nature?

For evidence upon this question, the world will carefully ponder the word of every scientist joining public debate. When he accepts scrutiny in the new field of human relations, the scientist will surely need all the cunning in the detection, identification, evaluation and utilization of primary influences which characterized his efforts and successes in the older, technological battle. His is an analytical mind, dispassionate, unbiased and presumably capable of healthful, constructive thinking in any field. Surely we may hope that the failure of his art in the Spring Forum is an exception to its intrinsic powers.

Office of Naval Research Discusses Ridenour's Views

by Alan T. Waterman and Robert D. Conrad

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Dr. Ridenour's article is one of the most sensible public statements yet made on the deliberately provocative question of the danger to science from military intrusion. He has correctly quoted and interpreted the policy of the Office of Naval Research; and he writes from a standpoint free from any connections, so far as we are aware, with research financed by federal funds.

Nearly two years ago, the Navy embarked upon a plan to support fundamental research through an organization which has since been designated by statute as the Office of Naval Research. The end of the war was in sight, although three months were to elapse before VJ Day. The Office of Scientific Research and Development was reducing its activities. University staffs were scattered, and their laboratories were either depleted or transformed into engineering development workshops by the exigencies of war. Industry was anticipating the staggering problems of reconversion. The prospects of resuming true research work were dim, yet the lessons of war were clear to all but the most undiscerning: the knowledge accumulated by research had made possible the developments which so greatly hastened our victory, and the resumption of the advancement of knowledge was vital to our security, our economy and our national welfare.

NAVY TOOK LEAD IN BASIC RESEARCH SUBSIDIES

No government agency existed for the purpose of extending federal support to basic research. Progress in creating a National Science Foundation was discouragingly (but understandably) slow. Something had to be done, however, and done quickly. It was under these circumstances that the Navy took the lead in making funds available for research.

Today a network of contracts is in operation in nearly all fields of physical and medical science. About three-quarters of the funds are placed with educational institutions. Not only is much significant research work being done, but also the shortage of scientists is being lessened by the employment of graduate students on many of these projects.

We wish to make it clear that there is no coercion, no interference, and a minimum of classification restriction in all this work. Proposals submitted to us are judged on their scientific merits by a competent staff of scientists and officers. The award of a contract is based on the known competence of the proposers, the amount of work already being financed in the same or contiguous fields, and the ever present considerations of budgetary limitations. Once an agreement has been reached, the contractor proceeds according to his own judgment, and the Office of Naval Research does not exercise supervision on scientific aspects except to share in decisions on major matters of policy, scope or aim.

A considerable amount of administrative work necessarily accompanies any government contract, and it is our aim to assist the contractor as much as possible in the fiscal, legal and operational aspects of the contract. Not the least of our assistance has been in the distribution of surplus equipment where most useful in various research projects.

Dr. Ridenour points out the danger of awarding funds on the basis of foreseeable military applications. This is closely related to the problem of secrecy. It would indeed be indefensible to expend naval funds for purely philanthropic purposes; some connection of the anticipated results with the national security must be recognized. But this is a very broad base. Few areas of endeavor are likely to be barren of results which affect the national defense.

THE PROBLEM OF SECURITY

The secrecy aspect is particularly vexing, since true scientific research is incompatible with any restrictions on the free flow of information. The arrangements we have found workable are as follows: The contractor is entirely free to publish the results of his work, but in his publications not to speculate upon its possible applications and naval or military developments. We expect that the scientists who are engaged on projects under naval sponsorship are as alert and as conscientious as we are to recognize the implications of their achievements, and that they are fully competent to guard the national interest. If a development emerges which should be classified, the contractor is given the option of proceeding with it under security restrictions, or having it removed from the campus to a government laboratory or to some other contractor. No one is asked to work in secret against his will.

It would be futile to pretend that the Army or Navy should remain the principal agencies for the federal support of basic research. We in the Office of Naval Research are constantly aware that, to a considerable degree, we are acting as interim trustees for the National Science Foundation of the future. When that agency is created, staffed, supplied with funds and ready for business, we expect to transfer to it a portion of the projects now on our books. But we believe it would be most unwise to transfer all of it, for it is vitally important that the Navy maintain close and responsible relationships with frontier research in all fields of science of any conceivable interest to the national defense. We have paid the price of neglect in the past, and the direct relationships we now have with the scientific fraternity must not be broken. What percentage of our program is appropriate for retention cannot be determined at this stage; it need not be great, but it must not be trivial.

EXPERT CONSULTANTS ADVISE ON DISTRIBUTION OF FUNDS

The figure of $20,000,000 cited by Dr. Ridenour is approximately correct at the time of this writing. It is distributed among over 400 projects, over half of which are for $20,000 or less. The "big research," to use Dr. Ridenour's words, gets the big money, for much of it is in costly equipment; but "small research" is also present, and is aiding individuals and small groups throughout the country. It should also be noted that "big" projects are not supported in full, but that the institution concerned bears a substantial portion of the expense in nearly all cases.

We have at all times sought the advice of others. Expert consultants are now available to us through the contractual network. Branch offices have been established. A Naval Research Advisory Committee of distinguished men has been formed, by invitations extended under the authority of the law creating the office. This Committee has already studied the program in detail, and will keep the activities of the Office of Naval Research under continued scrutiny and review.

In conclusion, it must be realized that this is not an easy task. There are no precedents in government for the comprehensive support of basic research as contrasted with the extensive development and engineering experience of the Navy. We are, in a very real sense, pioneers in establishing and maintaining the relationships of science and government which are becoming so essential to our national life. Our mistakes as well as our success will provide eventual guidance for the National Science Foundation.

Organization and Administration of the International Agency

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of the Atomic Energy Commission of the United States, the electricity produced by this reactor must be distributed by the Atomic Energy Commission or by the Government of the United States. I rather infer, from certain provisions of this law, that the contrary may well be approved by Congress; namely, that at the busbar, at the point where the electricity is produced by the generator, it will then be transferred for distribution to whatever kind of agency is the policy of that region or locality, or whatever the national policy may be in that respect; that it may be transferred to a State, that is to say, one of the States of the Federal Union, or to a private industry, or a public utility privately owned, or any one of a number of distribution agencies, depending upon the wishes of the people at that point. The fact that the production must be in national hands, in this context, does not require that the distribution should likewise be other than in accordance with the desires of the people of the local region or community. I mention that for its possible and logical value.

NEW TECHNOLOGY REQUIRES SUPERIOR PERSONNEL

As to internal management of the Atomic Energy Commission of the United States, I think the most important single fact to remember is that this is in a field which is by no means routine or known. This is in a field in which the technology is changing, and it is our purpose to change it as fast as we can. It is our purpose, within the Atomic Energy Commission of the United States, to make as many plants and facilities and knowledge obsolete as fast as we can. We concede that to be clearly the mandate of this Law. This is certainly the desire of everyone who appreciates the importance of fundamental knowledge and of new knowledge of the forces of nature.

In any case, here is a technology that requires a very high calibre of personnel, imaginative science, men who have a soaring imagination in the theoretical field and great skill in developing devices that will make fundamental knowledge grow. It will require a kind of restlessness among engineers not content with the way things have been done before. It will require, therefore, an atmosphere in which people of that kind will be willing and glad to serve.

From our point of view, in the Atomic Energy Commission, there are a number of considerations, a number of things about the atmosphere in which men work that we believe must clearly prevail. I do not necessarily say this is number one on that list, although it is certainly high on the list, but there should be appointment and promotion and management completely without partisan politics. In short, the operations should be upon a merit system, a system in which merit and nothing else is considered by way of judging in the recruitment of men and women.

Another circumstance that must be a condition of this operation is an understanding or a sense of its importance. If the tasks that are available for the Atomic Energy Commission were wholly police jobs, such as licensing and inspecting, and what we call in the United States "flatfoot jobs", it is inconceivable to me, as one with some experience in the management of large undertakings, that such people as I have been describing, men of imagination, restlessness and ideas and capabilities of that kind, could be recruited or, if recruited, could be retained in such an undertaking. So, a sense of the importance of the job, the opening up of new frontiers of knowledge, of driving back into these dark recesses where we know so little and know what we can learn may be so important for mankind, this sense of importance must permeate this organization, if its objectives are to be reached.

No amount of dollars, however great —and in the United States, over five hundred million dollars a year is a very large sum of money indeed for one project—whether it is five hundred million or more, no amount will achieve substantial results if the men and women engaged in the undertaking do not sense its importance to the future of men and women, and its importance in reaffirming that faith in knowledge which is one of the things that make us civilized. This inculcation of a sense of importance and encouragement of new ideas is perhaps the most important single managerial problem which we of the Atomic Energy Commission face.

I have emphasized this so much, because I would suppose that what I have thought about it in connection with a national agency, would likewise apply to the operation of an international agency, having, in part, comparable functions in respect to research and development.

TVA PRESENTED AS ANALOGY

I have referred—and I shall be very brief in this—to the TVA as a possible analogy. It may be fairly obvious that because the TVA is undertaken by the Government of the United States, but is administered within a region, a region which, compared to other sections of the United States, is relatively small, that it exhibits an interest in fitting the development of natural resources into the needs of a locality, into the special circumstances of a particular region of the United States, rather than seeking by one administration to blanket the entire country and thereby to destroy the strength that comes from diversity.

When this was first proposed so many years ago, as far back as the early twenties, and when it was before the Congress many times, most recently in 1933, it was stated that such an undertaking, the staffing and management of such an undertaking, was quite impossible under conditions in the United States. The magnitude of concentrated effort, the possibility of the injection of partisan politics, and the abandonment of the merit system, the difficulty of maintaining a high level of morale for technical enterprises—for the TVA is dependent almost entirely upon technical skill—that for all these reasons such an undertaking was thought to be an impossibility.

I think it gives a little sense of encouragement that another impossible thing has been found to be possible. The TVA is a going concern; it is a reality. It has been observed at close hand, I am very delighted to state, by many people from all over the world, including the Nations represented in this Committee, and there has been a

sense of the universality of its effort. This gives me some feeling of analogy, because, in the development of a technical enterprise which has as its purpose the furthering of human welfare, there is a common bond between men of all nations and languages, and that has been the almost universal comment of our distinguished visitors, whether they are technicians, politicians or men in private enterprise, that this is an undertaking which does not require transmission from one language to another, but that the aspirations of the people of the Tennessee Valley make technical skills work for their benefit. These are aspirations that are shared the world over.

TVA USED DIVERSE EXISTING ORGANIZATIONS

There is also a point in the TVA which may have some bearing on the international agency which you are considering, and that is its emphasis, too, upon the importance of diversity, of not putting into a single government agency all of the instrumentalities and means and devices whereby men satisfy their desires for more, for higher standards of living, for the development of their resources, for education, and so on. It was the effort of the TVA and its administration to stimulate and promote and encourage what we might call known institutions, the schools, private individuals, farmers, farm organizations, business men, and business organizations, all manner of those agencies of the people already in existence, whereby they express their desires in economic and educational fields; that while the technical job of controlling the river or developing, through the TVA's chemical laboratories, new kinds of phosphatic materials was the job of the TVA, the utilization of the river and of the electricity and navigation and flood control, and the utilization of these new technical means of fortifying the soil was for a host of public and private non-governmental or non-TVA institutions.

I think this notion that because government activity can be expanded to cover every phase of human life, it *should* therefore be so expanded is a fallacy of abstract thinking. There are ample demonstrations in experience, of which, I think, the TVA is one, and which we hope the Atomic Energy Commission, as it develops, will be another. There may well be government stimulation of a multitude of private or non-governmental activities, or in any of the known governmental activities, according to that pattern of life which the people in that locality or region deem best.

CONGRESS DETERMINED BROAD POLICY OF TVA AND AEC

There is one final point, in respect to the Atomic Energy Commission, which I should like to mention because of its possible bearing. The relations of an international agency to international legislative and other bodies is, of course, inherent in the problem that confronts this Committee. It is by no means an easy one and requires earnest and sincere thought and exploration. It may be interesting to point to the various places, the various levels, one might say, the various loci of decision of policy matters in the Atomic Energy Commission of the United States. It is an organizational problem in part. It is a problem in which the answer is partly constitutional in this country. On broad policy questions, the Congress of the United States, under our national Constitution, of course, is the determining body.

The law under which the Atomic Energy Commission operates is, of course, a product of action by this basic policy-making institution, the Congress, with the approval of the President, in accordance with the provisions of the Constitution of the United States. This Act embraces very broad policy considerations, some of which I read in the preamble or policy statement of this law, and others in the provisions of the law which state that certain major fields of research and development shall be pursued, and which lays down policies as to the security of information, and the like.

The President, on the executive level, and the Bureau of the Budget, which is an arm of the President, and the Military Liaison Committee to which I have referred, which is an arm of the President as Commander-in-Chief as well as an arm of the War and Navy Departments, and the Joint Congressional Committee are the other areas, the other locations for decisions on various kinds of policy questions.

Then there are questions of policy which the Commission is to determine, such as the policy decision towards diversity of effort, towards the use of existing research agencies for certain purposes. The Commission delegates to the general manager other decisions of a different kind, largely administrative, largely managerial. The general manager then delegates to the field managers at Los Alamos, Hanford, and Oak Ridge, and other points, other responsibilities of management. Those field managers, in turn, delegate to others.

TVA AND AEC PUT POLICY INTO EFFECT

This general principle of different kinds of questions of policy and management being decided at different levels and by different individuals, and at different locations is, of course, common to human organization the world over, in one way or another. They are hard to escape. I mention them because there seemed to me quite a lot of analogies and quite a good deal of experience in this field, of finding a level at which decisions of varying degrees of complexity or magnitude or scope may be determined. The Atomic Energy Commission and the TVA both have this in common. The Congress of the United States declares the policy that the Tennessee River shall be made a controlled river—a very broad decision appropriately to be made by the legislative body of the whole country. It then directs the Board of Directors of the Tennessee Valley Authority to carry that decision into effect, not by deciding precisely where each of the dams should be located—which is an engineering and technical matter—but by determining the general policy that the river shall, by technical means, be made controlled and navigable and so on.

So the Atomic Energy Commission, through the Congress, is told to do further research in fundamental nuclear science, but not precisely how. These varying kinds of policy decisions, as I say, have a good many analogies in human experience, both current and in the past.